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OUR ISOLATED LIGHTHOUSES.

FOLLOWING upon our article of last week, Mr. T. V. Luke, Director of Indian Telegraphs, in a recent letter written to the *Standard*, makes the suggestion that telegraphic communication with light vessels might possibly be made without the aid of a complete metallic circuit, instancing the well-known method of telegraphing across rivers by means of uninsulated wires, and also some experiments made by Mr. Willoughby Smith, by means of which communication was actually established without a metallic circuit between the shore and a boat moored some quarter of a mile from it, a telephone and vibrating sounder being employed. No doubt communication could be kept up with a light-ship by means of a cable not directly connected with the ship, and we believe it has been suggested that this might be done by terminating the cable and buoying it below the ship by a length of the same coiled in a flat spiral, a similar spiral being attached to the ship and in connection with a telephone receiver. There is, we think, very grave doubt indeed whether such an arrangement would be anywhere within the range of practicability, even under the most favourable conditions, and it is these favourable conditions which are not met with when the communication is most required. What is required is communication when the sea is raging and the light-vessel tossing and rolling about, and when silence is the last thing obtainable, conditions which completely upset the idea of adopting the method suggested. Mr. Luke, in the letter referred to, says somewhat glibly:—"I think I am justified in saying that experiments have shown that the difficulty of establishing electric communication with a floating lightship can be overcome, and that this problem need not stand in the way of the desirable scheme being carried out." With all due respect to the director of the Indian Telegraphs, we think that he has very greatly underestimated the difficulties of the problem. The comparatively recent experiments made by the Telegraph Construction and Maintenance Company with reference to keeping up communication with a lightship appear to have been fairly successful on the whole, and the final cessation of the communication appears to have been due more to the absence of any proved benefit arising from the scheme than to a failure in the practicability of the arrangement. Had the experiment been made in a locality where the advantages of the communication would have been more certain, it is probable that more would have been heard of the experiment, and something practical would have arisen from it. In the meantime, public interest appears to have been aroused to some extent in the matter, and possibly more may come of it.

ELMORE MINUS BURNISHER.

MR. ALEXANDER WATT, author of "Electro Deposition," in a letter to a contemporary, raises an important question on the value of Elmore tubes as steam pipes. We publish the letter in full in another column. Mr. Watt remarks that metals deposited electrolytically do not adhere well, if at all, to their kind. Thus, gold will not adhere to gold, nickel to nickel, nor copper to copper; and if a burnisher passes over the surface of a revolving iron mandril coated with copper it leaves a bright and highly-polished (or burnished) surface to receive the next deposit, with which it has no cohesion, and thus becomes a distinct and separate layer or film.

A tube so constructed is practically a series of tubes, or—regarding it simply as a substance—it is layer superposed upon layer, without cohesion. The effect of heat upon such a structure is to disintegrate it. Mr. Watt concludes by remarking that there would appear to be no remedy for the evil which results from the foliated character of the deposit except the abandonment of the burnisher. Mr. Watt seems to have no compunction in being cruel to be kind. The one characteristic of the Elmore process over others, the foundation of everything Elmore, must be removed in order to avoid the evils which it brings in its train! In an early article on the subject we quoted authoritative tests on electro deposited tubes, and were informed by the Elmore interest that the tests did not apply because the material was not prepared by the Elmore process.

If they had been, the results would have been different.

Perhaps Mr. Watt's contribution to the subject correctly indicates the nature of the difference. Under any circumstances, we think that no deduction as to the breaking strain of Elmore tubes as steam tubes should be drawn from tests other than actual tests under steam. Such a test as was made at the Press visit to the works is no criterion whatever. Mr. Watt's views are entitled to much consideration, and it will be seen that in regard to the nature of the material obtained by the burnishing process, they are in distinct contradiction to the Elmore views as defined in the prospectuses and elsewhere. "Tough, fibrous, cohesive," and similar adjectives are used by Elmore; "stratified" would, perhaps, correctly represent Mr. Watt's opinion.

It is now three-and-a-half years since the fatal explosion on board the ss. *Elbe*. It was during the excitement thereby created that the first Elmore company was successfully formed to work the process to produce solid copper pipes by electro-deposition. On enquiry amongst steamship people we fail to discover any Elmore copper pipes in use. There may be some, but we cannot find them. Although the pipes are few, the companies are many, and the process is a good one for companies—using the public as the electrolyte; layer after layer of mint gold has been deposited upon mandrils of prospectus paper, with any amount of burnishing going on all the time. These successive companies are designedly foliations, and the burnishing has been an undoubted success in their case, but, in what steamer can we see the pipes? There is only one other question we would like to ask the Elmores. Some time ago a paper was read before the Institution of Naval Architects, by a chief engineer surveyor of Lloyd's, which favoured the Elmore process. Upon what condition was that paper read, and, paraphrasing "Hans Brietman's barty," where is that author now?

A French Contemporary on Edison.

REFERRING to the commonly accepted notion amongst the unenlightened public that Edison is the only inventor of any consequence, a Parisian contemporary somewhat sarcastically sums up the qualifications and achievements of this remarkable man. Without noticing this in detail, we may observe that the chief complaint against Edison seems to be that he does not possess originality, and much of the tirade against him is taken up with an attempt to show that he has been particularly fortunate in adapting other people's ideas, overlooking the fact that ideas are of little worth unless they can be put into some practical shape. Our contemporary especially prefers the charge of plagiarism against the American electrician, backing it up with a reference to a recent interview with him, in which he was reported to have stated that he was deeply engaged upon the problem of producing electricity direct from carbon without the mediation of any motive power. The interviewer apparently made Edison speak in very "pompous and important terms about his new idea," which he is said to have been at work upon for the last nine years. But our contemporary, who probably considers that no new idea can possibly originate outside France, at once "jumps upon" him (as Edison himself would probably say), and endeavours to show that whatever there is of value or novelty in the idea was proposed by Mons. Le Bel ten years ago (*Revue Scientifique*, August 27th, 1881); further, that two other Frenchmen, namely, Mons. Badoureau and Mons. D'Arsonval, have been engaged in endeavouring to develop this carbon idea. It is not the first time "qu'on prend la main de M. Edison dans le sac . . . . . des autres," says our somewhat over-jealous contemporary. Probably the truth of the whole matter is, that Mr. Edison has been misrepresented by his interviewer; surely, he would be the last man to deny to others their fair share of glory, and to take credit to himself that is rightfully due to others. After all, it is rather absurd to make a fuss about; the new source of energy that is to revolutionise everything and put dynamos and batteries in the shade, hasn't put in a very strong appearance yet.

Electrical Waves.

THERE were two important papers on electrical waves in the *Annalen der Physik* a short time ago. A. Elsas described how he used a Daniell cell and hung a telephone upon a continuation of a wire connected with one of the poles of this cell. The connection between the poles of the battery was broken close to these poles by a peculiar form of current breaker. Under these conditions the telephone was found to give a tone which depends upon the self-induction and capacity of the wire upon which it is hung. Various modifications of this experiment are described, and the telephone is employed in place of a Hertz resonator, to show waves on the wire of the open circuit. H. Ernst Lecher describes a new method which he has devised for studying Hertz's phenomena. Instead of a resonator of the type employed by Hertz, this physicist uses a Geissler tube. Two parallel wires, of known self-induction, terminate at one end in condenser plates, which are charged in an oscillatory manner by a large Rhumkorff coil excited by storage cells. Upon the other ends of the parallel wires rests the Geissler tube. A short wire is slid along the parallel wires connecting them across like a bridge between the two parallel wires on a sonometer. At certain definite points the Geissler tube glows, and the wave-lengths of the electrical oscillations can thus be measured. Lecher finds that the velocity of electricity in metallic wires is of the same value as the velocity of light.

Telephonic Induction.

THE development of long distance telephony has necessitated the adoption of methods for preventing inductive disturbances either from neighbouring telegraphic or neighbouring telephonic circuits. The running of a metallic loop on the well-known twist system is the usual cure for the disturbing influences, and when properly carried out has always proved a complete success. We have seen it announced that in the case of the new London-Paris telephone line, that although sufficient silence is obtained for practical work there is not absolute silence; it would be interesting to know to what this is due. On the English side, over the length of 80 miles where the ordinary twist system is employed, we believe absolute quietude exists; it would therefore appear as if the disturbance which is stated to exist must arise from the French length of line, and it would seem that in this case the twist system has been inefficiently carried out, or that some other method than the twist pure and simple has been adopted. The metallic loop method, which has hitherto proved to be the only one capable of getting rid of inductive disturbance, is, of course, expensive, and any arrangement which would render silence possible when single wires are used, would be of very great value. Mr. Carty, in his paper on another page, seems to indicate that such a consummation is possible if proper precautions are taken to avoid electro-magnetic induction. The experiments do not appear to be very conclusive on the subject, but they appear to be worth following up, seeing the great commercial value of success resulting from them.

RESEARCHES ON THE ELECTROMOTIVE FORCE OF A METAL IN A SERIES OF ELECTROLYTES.

The table given below exhibits the average results of a series of experiments recently undertaken by G. Magnanini with a view to ascertaining the variation of the electromotive force of a metal with the nature of the electrolyte in which it is immersed.

Poggendorf's "compensation" method, with a capillary electrometer, was used for making the various measurements.

At the extremity of the rheostat the difference of potential was maintained at one volt and the metals were successively immersed in each of the series of electrolytes. Comparison was made with zinc, or cadmium, or lead in normal sulphuric acid.

The electromotive force was calculated with respect to zinc in normal sulphuric acid to hundredths of a volt.

On examining the table carefully it will be observed that the ordinary salts give values generally not very different one from another, the more important deviations occurring in electrolytes which may be assumed to have an exceptional action upon the metal. Oxidising agents are a good example of this, for they increase the value of the electromotive force while on the other hand reducing agents diminish this value.

It appears also that the deviations very much depend upon the character of the metal under examination.

The original paper may be consulted in the *Gazzetta Chemica Italiana*, Vol. xx., pp. 308-311.

Electrolyte. Strength of solution in grammes per litre.	Metal. Zn.	Cd.	Pb.	Sn.	Cu.	Ag.
½ mol. H_2SO_4	0·0	35·6	51·3	51·3	100·7	121·3
1 „ Na OH	− 32·1	19·5	31·8	0·2	80·2	95·8
1 „ KOH	− 42·5	15·5	32·0	− 1·2	77·0	104·0
½ „ Na_2SO_4	1·4	35·6	50·8	51·4	101·3	120·9
1 „ $Na_2S_2O_3$	− 5·9	24·1	45·3	45·7	38·8	64·8
1 „ KNO_2	11·8 (*)	31·9	42·6	31·1	81·2	105·7
1 „ $NaNO_2$	11·5	32·3	51·0	40·9	95·7	114·8
½ „ K_2CrO_4	23·9 (*)	42·8	41·2	40·9	94·6	121·0
½ „ $K_2Cr_2O_7$	72·8	61·1	78·4	68·1	123·6	132·4
½ „ K_2SO_4	1·8	34·7	51·0	52·4	101·1	123·6
½ „ $(NH_4)_2SO_4$	− 0·5	37·1	53·5	57·6 (*)	101·5	125·7
¼ „ $K_4FeC_6N_6$	− 6·1	33·6	50·7	41·2	(*)	87·8
¼ „ $K_6Fe_2(CN)_{12}$	41·0 (†)	80·8	81·2	130·9	110·7	124·9
1 „ KCNS	− 1·2	32·5	52·8	52·7	52·5	72·5
1 „ $NaNO_3$	4·5	35·2	50·2	49·0	103·6	114·6
½ „ $Sr(NO_3)_2$	14·8	38·3	50·6	48·7	103·0	119·3
½ „ $Ba(NO_3)_2$	21·9	39·3	51·7	52·8	109·6	121·5
1 „ KNO_3	(*)	35·6	47·5	49·9	104·8	115·0
½ „ $KClO_3$	15 to 10·0 (*)	39·9	53·8	57·7	105·3	120·9
¼ „ $KBrO_3$	13 to 20·0 (*)	40·7	51·3	50·9	111·3	120·8
1 „ NH_4Cl	2·9	32·4	51·3	50·9	81·2	101·7
1 „ KF	2·8	22·5	41·1	50·8	61·3	61·5
1 „ NaCl	...	31·9	51·2	50·3	80·9	101·3
1 „ KBr	2·3	31·7	47·2	52·5	73·6	82·4
1 „ KCl	...	32·1	51·6	52·6	81·6	107·6
½ „ Na_2SO_3	− 8·2	28·7	41·0	31·0	68·7	103·7
(‡) NaOBr	18·4	41·6 (*)	73·1	70·6 (*)	89·9	99·7
1 mol. $C_4H_6O_6$	5·5	39·7	61·3	54·4 (†)	104·6	123·4
½ „ „	4·1	41·3	61·6	57·6	110·9	125·7
½ „ $C_4H_4KNaO_6$	− 7·9	31·5	51·5	42 to 47	100·8	119·7

(*) Not constant.
(†) Constant after a time.
(‡) A quantity of bromine was used corresponding to Na OH = 11.

THE ABSOLUTE VALUE OF THE MAGNETIC ELEMENTS.

At the meeting of the Paris Academy of Sciences on January 5th, a note from Mons. Th. Moureaux was presented relating to the measurement of the absolute value of the magnetic elements.

The observations at the observatory in the Park of Saint Maur are continued with the same apparatus and reduced according to the same methods as in preceding years. The curves given by the magnetograph are drawn for every hour of the day and the values corresponding to the points of reference are established by absolute measurements which are repeated every week. The sensibility of the apparatus for observing the variations is verified by frequent graduation.

The absolute values of the magnetic elements on the 1st of January 1891 are deduced from the mean of the hourly observations made on December 31st, 1890 and January 1st, 1891.

The secular variation of the different elements in 1890 was obtained by comparison between the following values and those which were observed on the 1st of January, thus :—

Elements.	Absolute value on Jan. 1st, 1891.	Secular variation during 1890.
Declination	15° 35′·9 ...	− 5′·5
Inclination	65° 10′·6 ...	− 1′·6
Horizontal component ...	0·19554 ...	+ 0·00030
Vertical „ ...	0·42272 ...	+ 0·00011
Total force	0·46576 ...	+ 0·00023

The observatory in the Park of Saint Maur is situated in longitude east 0° 9′ 23″ and 48° 48′ 34″ latitude north.

The meteorological and magnetic observatory at Perpignon under the direction of Dr. Fines is situated in 0° 32′ 45″ longitude east and 42° 42′ 8″ latitude north.

The magnetic observations made there are taken by instruments similar to those in use at Saint Maur, and calculated according to the same method.

The values of the magnetic elements on the 1st of January, 1891, deduced from the twenty-four hourly observations made by means of the magnetograph, and referred to the absolute measurements made on the 26th, 28th, and 30th of December, 1890, were the following :—

Element.	Absolute value on Jan. 1st, 1891.	Secular variation in 1890.
Declination	14° 24′·1 ...	− 4′·9
Inclination	60° 16′·2 ...	− 2′·3
Horizontal component ...	0·22242 ...	+ 0·00037
Vertical „ ...	0·38947 ...	+ 0·00004
Total force	0·44850 ...	+ 0·00021

ELECTRICAL INDUSTRIES IN ST. LOUIS.

(Abstract of Address by Francis E. Nipher, Retiring President of the Engineers' Club of St. Louis, America.)

The first commercial lighting that might fairly be called successful, was inaugurated by Charles Heisler in 1878 at Conrad's brewery. Alternating currents were used in operating arc lamps. Later he adopted a series system of incandescent lighting, still using alternating currents.

In England the general impression still seems to be that incandescent lamps cannot be successfully operated on long lines without the use of converters and an alternating multiple system. Such was the general opinion in this country until Mr. Heisler pushed boldly into the field and finally operated 50 miles of line wire from one dynamo. The Heisler Company, of this city, manufacture only central station plants, of which about 70 have been established. The largest plant of about 5,000 16-candle lamps, is operated by the Municipal Electric Lighting Company in this city. The total capacity of the plants established by this company is about equivalent to 60,000 16-candle lamps. These lamps require 5 ampères, 14 volts, and are said to yield 32 candles with a life of 600 hours.

The Municipal Electric Light and Power Company, which began street illumination May 1st, 1890, are now operating 3,300 arc lamps of the Wood pattern, each lamp requiring 9·6 ampères, 47 volts. Of these lamps 1,400 are furnished to private customers.

These lamps are operated in 61 circuits, the longest of which is 21 miles and carries 60 lights. The total length of the lines is about 1,000 miles, the most distant lamps being 10 miles from the power house. The company has 70 60-light and 12 30-light dynamos of the Wood-Gramme pattern, furnished by the Fort Wayne Company. The area covered by their lines is about 50 square miles, and the area actually illuminated is about 30 square miles. The power is furnished by six 600-horse-power engines and six high speed engines of about 75 horse-power. The total energy output of the plant is about 36,000 horse-power hours per day.

The steam supply system is in duplicate throughout.

Independent of this double system of steam supply is an independent connection for 1,500 horse-power, to be used during the day when the loads are light.

The same company operates a Heisler incandescent plant, developing the equivalent of 5,000 16-candle lamps on 150 miles of line wire. At this station four high speed engines are used, with a total capacity of 700 horse-power.

The Laclede Gaslight Company also operate a Heisler plant of 814 32-candle lamps, each requiring 5 ampères, 14 volts. These lamps are used in alley lighting. These are operated in four circuits from two dynamos, of which the longest line is 26·5 miles, the shortest 16·1 miles. The total length of the four circuits is 86.4 miles, and the area lighted is four square miles. For indoor lighting, the Laclede Company operate a Brush alternating system with converters, of which the longest line is 14·1 miles. These circuits are also four in number, with a total length of 35·3 miles. The system employs 41 converters, with a capacity of 1,245 16-candle lamps.

The power is obtained from two triple expansion Williams engines, having each a capacity of 250 horse-power, and one single cylinder Westinghouse engine of 45 horse-power.

There are in all at this plant two 1000-light, three 900-light and one 650-light dynamos, making a total capacity of 5,350 lights. The Missouri Electric Light and Power Company began operations August 1st, 1889, operating the Westinghouse system. They now have about 1,255 converters in use as follows :—

100	10-light converters ...	...	1,000 lights.
500	20-light „ ...	...	10,000 „
250	30-light „ ...	...	7,500 „
400	40-light „ ...	...	16,000 „
5	100-light „ ...	...	500 „
			35,000

In November, 1890, the average number of lamps in operation during lightest loads was 3,000 16-candle lamps. During heaviest loads the number was 16,000, or not quite half the capacity. There are now 20 feeders leading from the station, the longest of which is five miles in length. There are eight 3,000-light dynamos, each capable of delivering 150 ampères at 1,000 volts terminal potential, and an additional dynamo of the same capacity will be added during the present month.

The Missouri Company also operates 150 miles of alley lamps, requiring about half the capacity of one of the dynamos. These lights are run in a series-multiple system, 20 50-volt lamps being connected in series between mains at a potential difference of 1,000 volts. There are 700 of these lights on 35 lines, between three mains, and covering an area of about 12 square miles.

There are now in operation eight 300-horse-power Westinghouse engines, seven of which are required at the time of heaviest load, when the indicated horse-power was in November last, on the average about 1,650.

During July, 1890, the indicated horse-power hours per day was 11,040, and during the following November it was 19,800.

There are about 50 isolated electric lighting plants in St. Louis, having in all about 27,000 lights, and representing about 2,700 horse-power. The cost of these plants is on the average $9 per lamp, or $243,000. Of these plants 38, representing 22,135 lamps, have been installed by the Edison Company. The largest plants are the Edison plant in the Exposition building, which has 5,000 lamps, and the United States plant at the Custom House, which has 1,930 lamps.

The Union Depôt Railroad Company are now operating 14 miles of double track by electricity, using a Thomson-Houston plant. At present eight compound dynamos are in use, each capable of delivering 150 ampères at 500 volts terminal potential. When complete, 22 dynamos will be used, making 2,200 horse-power in all.

At present 24 motor cars are run during light traffic and 34 motors and trail cars are used during the heavy traffic in morning and evening. The number of cars will be considerably increased in the near future in order to provide for the increasing traffic.

During heavy traffic with 34 cars the power required is at the rate of 10 horse-power per car, and during light loads the power required is 6 horse-power per car. The number of horse-power hours per day is about 7,350.

The plant is supplied with four Hamilton-Corliss engines with rated capacity of 250, 350, and two of 500 horse-power. At present one 500 horse-power engine will operate the entire road.

The Lindell Railway Company are also introducing the use of electricity. At present 22 cars are being operated by electricity, and in a few days the entire road of about 33 miles of single track will be in operation. It is reported that when completed the number of cars will be 67. I was, however, unable to obtain any definite information concerning the operations of this road.

During the whole progress of the electrical industry, it has been most instructive to see how some new improvement has sometimes changed the whole aspect of affairs, as when reserve troops are thrown into a doubtful contest. Plans and machinery which the prudent and conservative engineer had decided to be valueless, came then to the front, and the struggle of contending interests began on new ground and along new lines.

For example, Faraday invented the transformer or converter in 1831. It was an iron ring upon which his primary and secondary wires were wound. Rhumkorff and Ritchie in their well-known induction coils, showed how to convert a large current of low potential into a small current of high potential, and at the same time used a laminated core composed of a bundle of iron wires.

Then it was discovered that the induction coil is reversible, and that a small current of high potential can be converted into a large current of low potential.

It is interesting to observe that in 1883 the U. S. Patent Office refused a patent to Bernstein for a converter, on the ground that he could not possibly get out of the converter on the secondary wire, a larger current than he put into it on the primary. In 1886 the same office gave Gaulard and Gibbs a patent for the same device,* the impossible having meanwhile become possible. Then came the great step of placing the iron around the primary and secondary coils, instead of within them. This was what brought it to the front as the powerful ally of the alternate current dynamo which then became the formidable competitor of the secondary battery.

In a similar way the work of Dr. Wellington Adams of this city on the equipment of electric motor cars brought about a complete revolution in their construction. When his paper read before this club, April 23rd, 1884, was published, the building of electric locomotives like those of Siemens and Edison wholly ceased. The entire subsequent development of the electric railway has proceeded along the lines which Dr. Adams laid down. The application of the power directly to individual car axles, centreing the motor and its gearing upon the axle, so that different axles may move independently without deranging the gearing, the provision for the oscillation of the field on the car axle as an axis, while held in position by elastic resistance, all this was first done in our city, and was first proclaimed to the public by Dr. Adams in a meeting of this club.

Over and over again have we learned that we should have a watchful eye upon those things which have no practical value. Students and engineers alike are prone to ignore with systematic deliberation, those things which have no commercial value. But the history of scientific discovery and of engineering progress is simply a history of the work of men who applied their brains to useless things and made them useful; who successfully did what had been considered hopeless or had been overlooked as worthless.

I do not wish to ignore the fact that the commercial instincts of mankind should be considered, in deciding what is to be undertaken. No company of business men should be willing to expend all of their capital in convincing themselves that the undertaking might have succeeded, if they had had a few more millions of capital and a few hundred years of time.

It is not an easy thing to draw the line between the cranks and the engineers. Different people draw the line in different places. It is a matter of individual judgment. Time and the march of events have frequently made it necessary to revise or reverse such judgments. We pass by imper-

* Thompson's Dynamo-electric Machinery.

ceptible stages from the well-marked engineering lunatic, who is trying to make an engine or a dynamo drive itself, and who seems to have an idea that it will also be able to drive anything and everything else in the universe that needs driving, to the man who believes he can operate street cars or illuminate great cities by electricity; that he can telegraph through ocean cables and drive ships and railway cars by steam.

Fortunately or unfortunately, men do often make mistakes in deciding what they should undertake. They spend their lives or their fortunes in trying to do things before the times are ripe, and while the difficulties are too great. They achieve only a partial success, which commercially is no success, and those who follow them enjoy the benefits of their labour, and finally not only reap the pecuniary reward but monopolise all the glory.

AN EARLY MAGNETO-ELECTRIC MACHINE WITH FIELD MAGNETS EXCITED BY THE ARMATURE CURRENT.

By A. M. TANNER.

The question as to who first invented the self-exciting dynamo having recently been discussed in your columns by Prof. S. P. Thompson and Mr. S. A. Varley, it is pertinent in this connection to state how closely another inventor approached the same subject. I copy the following from an English patent of Soren Hjorth, dated April 11th, 1855, No. 806, for a magneto-electric machine, viz., "Permanent magnets acting on the armatures brought in succession between their poles induce a current in the coils of the armatures, which current, after having been caused by the commutator to flow in one direction, passes round the electro-magnets, charging the same, and acting on the armature. By the mutual action between the electro-magnets and the armatures an accelerating force is obtained which, in the result, produces electricity greater in quantity and intensity than has heretofore been obtained by any similar means."

It will be seen that in this reference the magnetic field in which the armatures revolve is composed of permanent *and electro-magnets*, and that the coils of the latter are traversed by the commutated current of the armatures in order to excite said electro-magnets.

A French patent of Soren Hjorth, dated July 3rd, 1856, No. 28,365, also sets forth the same invention as the above cited English patent with several additional features. The field magnet coils in both instances are in series with the armature coils. It is interesting to note in connection with this early machine of Hjorth that, had he omitted the permanent magnets, he would undoubtedly have had the self-exciting dynamo, the discovery of which is variously attributed to Varley, Wheatstone, Siemens and others. It is unnecessary to state that Hjorth was a pioneer working in the same direction, and also deserves considerable credit for what he did *as early as the year* 1855.

[We publish this article out of courtesy to Mr. Tanner, who has from time to time sent us valuable contributions, but Hjorth's specification is well known amongst electricians here.—Eds. Elec. Rev.].

THE MEASUREMENT OF CONDUCTIVITY APPLIED TO THE DETERMINATION OF THE CONSTITUTION OF COMPOUNDS.

Electricity is becoming more and more the hand-maid of chemistry, and chemistry of electricity. One of the recent applications of electricity in the study of chemistry is in determining whether any chemical action takes place when two substances are placed in the same solution and yet do not show any obvious signs of having combined with each other. As an example we may quote boric acid and mannitol when in aqueous solution; the assumption has been made that under these conditions the two combine to form etherial salts. In order to test the truth of this view, G. Magnanini has determined the electrical conductivity of solutions of boric acid containing different amounts of mannitol, using the apparatus designed in 1889 by Ostwald. The molecular conductivities of these substances were calculated on the hypothesis that in each case the conductivity was due solely to the presence of one of the two substances.

The molecular conductivity of boric acid is found to be enormously increased by the addition of mannitol, the increase being greater the larger the amount of mannitol added. Now mannitol is a non-conductor of electricity, hence we must assume that some electrolyte is formed in the solution, increasing in amount according to the amount of mannitol added.

It further appears that the molecular conductivity of boric acid in the presence of mannitol decreases according as the dilution increases, a behaviour which is quite different to that of all other electrolytes. One may, however, assume in this case that the compound of boric acid and mannitol first formed is subject to hydrolysis and therefore will be decomposed by the addition of water. The decomposition of the electrolyte with increasing dilution, then, explains the decrease in the conductivity which takes place.

This view is further supported by the fact that solutions containing a larger proportion of mannitol behave normally up to a certain dilution, the conductivity regularly increasing; but a maximum is after a time reached, and a decrease then sets in, no doubt due to the fact that the hydrolytic dissociation has become greater than the electrolytic dissociation.

When the theory of Guldberg and Waagi is applied the conclusion is inevitably arrived at that a compound of boric acid and mannitol is formed in the above solutions, containing three molecules of the former to one of the latter.

The amount formed at constant temperature is a function of the amounts of water, boric acid and mannitol, and may be determined with respect to these last two substances in accordance with the laws of chemical equilibrium, since the electrical conductivity of a solution containing different amounts of boric acid and mannitol in the same amount of water varies in accordance with the same laws.

Other chemical substances containing hydroxyl groups (*i.e.*, OH) are found to increase the conductivity of boric acid solutions.

Quite recently Magnanini has applied his new method of studying the constitution of solutions to the investigation of the molecular composition of compounds existing in boric acid solution to which some dulcitol has been added.

The variations of the molecular conductivity of boric acid solutions in the prescence of dulcitol are precisely of the same character as those which occur in the presence of mannitol, with this difference, however, that from the observed values of the conductivity in the case of dulcitol, no simple relation for the molecular composition of the electrolytic compound or compounds can be calculated. This renders it probable that several compounds of boric acid and dulcitol exist together in the solution.

HIGH POWER BATTERIES.

Mr. J. T. Sprague, in an article contributed to the *English Mechanic* gives some interesting and valuable details of experiments made by him with reference to the merits of the more powerful oxidants used in primary batteries. For the purpose of the experiments he constructed a cell with a small porous vessel, which would conveniently hold 400 fluid grains with the carbon plate, so that he could have the conditions exactly alike for each substance. The external circuit consisted of the necessary connections, a large tangent galvanometer, and a copper depositing cell to measure the total work done by the 400 grains of each oxidant.

The following shows the measured resistances of the liquids:

Resistance of Battery Liquids.

	Sp.gr.	Resist.
1. Sulphuric acid 1, water 12, vols.	1·085	60·
2. Sulphate of copper sat. sol.	1·172	656·
3. „ same + ¼ vol. sulp. acid 1, water 10 ...	1·155	195·5
4. Potash bichromate sat. sol.	1·048	698·
5. „ same + $\frac{1}{12}$th vol. H_2SO_4	1·139	70·
6. Soda bichromate sat. sol.	1·422	220·
7. „ same + ½ vol. H_2SO_4	1·552	80·4
8. Chromic acid, Sullivan's, 1,000 parts to water, 1,250	1·353	48·7
9. Chromic acid 2,250 grs. + 1 fl. oz. H_2SO_4	1·454	57·9
10. Nitric acid	1·375	5·69

The liquids were prepared as usual for battery purposes, in the carbon cell; the acid for acting on the zinc being provided in the outer vessel of the strength of line 1. The bichromate of potash would require a doubled quantity of acid for use as a single cell. The soda bichromate, line 7, was a saturated solution allowed to cool and settle, as it is not easy to hit the exact proportions, and half its volume of sulphuric acid (strongest OV sp.gr. 1845) added. The chromic acid was prepared according to the instructions of the maker—1 lb. in 1 pint of water and 7 fluid ounces of sulphuric acid; the actions of the various liquids were plotted out in curves. These curves brought out the relative values very forcibly. The bichromate of potash showed a rapid loss by so-called polarisation; in fact, it is hardly possible to measure the early current, it falls so quickly. The very small quantity of work possible justifies the statement that this once-valued salt is now worthless in batteries, compared with others now to be obtained.

Bichromate of soda and chromic acid run each other very closely; but the acid has more staying powers and does more work. Both show a growing current at first.

The curve given by Mr. Bottone's solution shows the great effect produced in the early part of the work by the addition of chlorate of potash to the chromic acid, as well as the increase in the total effect.

The nitric-acid curve, which extended over 30 hours before sinking to the level of the others (which level is really the action of the sulphuric acid on the zinc without any oxidant), shows the vast superiority of this over all other oxidants, so far as the production of current is concerned. The rising curve here is known to be due to lowered resistance (and, it is said, higher E.M.F.), as nitrous acid is generated and dissolved.

The copper voltameter showed the work in ampère-hours of each 400 grains to be:

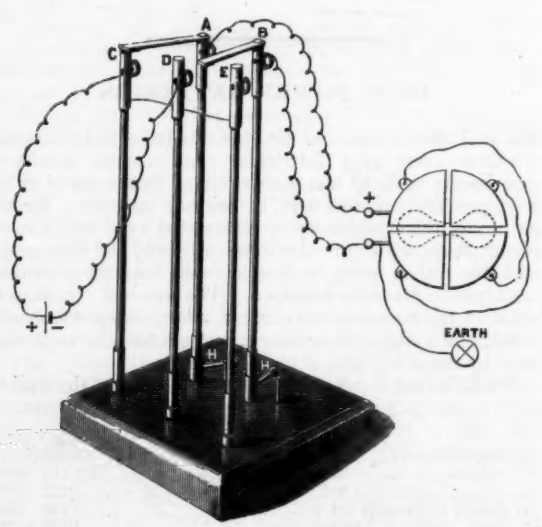
Nitric acid	16·
Soda bichromate	5·
Potash ,, ...	1·7
Chromic acid, Bottone's solution 9 ...	6·4

But the nitric acid had not gone to the level of the rest, as it was stopped at 24 hours; and the bichromate of potash gets credit for too much, as the last six hours of its curve do not really belong to it, but to the zinc and acid.

AN ELECTROSTATIC COMMUTATOR.

By ROLLO APPLEYARD.

THE electrostatic commutator here shown is a simple apparatus, of small capacity and high insulation, for effecting all the ordinary connecting operations with electrometers.



It consists of five insulating rods, three of which, C, D, E, are fixed; A and B are fitted into brass sockets in the base-board with spring washers, so as to be capable of turning about a vertical axis by handles, H.

At the top of each fixed rod is a binding-screw, tipped with platinum, and having a slightly convex surface of contact.

The rods, A, B, carry contact springs with corresponding hollows at their rubbing ends, so that when the handle is moved the spring slides on and drops into place easily.

The screws C and E are connected permanently together by a wire.

A and B are the quadrant terminals; D, and either C or E, are for the test wires. This method of connecting prevents all possible chance of short-circuiting a cell under test. By sliding the springs on to C and D, the quadrant in connection with A, becomes +, and that joined to B is −. We may reverse by sliding the springs to D and E respectively.

The electrometer quadrants are connected together by joining A to C and B to E—in which position the springs should always be left after a test.

In intermediate positions the quadrants are completely insulated. When very high insulation is required, some dessicating arrangement may be employed. With a slight modification of the handles, a place might be found for this commutator inside the electrometer case itself, the handles being entirely outside, below the base.

RANKIN KENNEDY'S NEW ELECTRICAL DISTRIBUTION METHOD.

By RANKIN KENNEDY.

(*Continued from page* 394.)

III.—MOTIVE POWER.

IN the issue of March 27th was illustrated the complete method, and the manner of obtaining electric light from sub-stations of storage batteries, dynamotors and alternating transformers, all operated from the one plant.

Motive power is easily obtained from those sub-stations, consisting of storage batteries and dynamotors. As they send out low-pressure continuous currents, ordinary self-regulating motors of good design can be used in these circuits. We need not describe any one form of these motors here, they being so commonly known; on this new system they can be used to any extent, and of any power.

In some special cases, a dynamotor is coupled into the high-pressure mains and placed in a workshop where current, say, for electro-typing is required, and also power being required to run the machinery in the workshop, this dynamotor supplies both current and power for the workshop; these dynamotors are to be worked by this new method by the two currents in series.

Alternating current motors are to be operated by the alternating transformers. Alternating current motors are not very common; some people don't know of their existence, in fact. Nevertheless, I shall take this opportunity of discussing alternating current motors in general, and describing the motors invented for use in this new method of distribution in particular.

The fact that one alternating dynamo could drive another one when they were coupled electrically, and once started up to synchronous speed, is well known and is ancient history. An alternating current dynamo, like the continuous current dynamo, is reversible; but, unlike the continuous current dynamo, it is not self-starting; it will run as a motor at one speed only.

These facts being known, inventors have devised various schemes for starting alternators used as motors, and running them up to synchronism.

Alternators used as motors require to have field magnets steadily excited, hence the alternating current cannot be used for the field excitement unless it is first redressed into unidirection currents.

Mr. Mordey devised a method of starting and exciting an alternator to be used as a motor. The alternator so to be used is to have a small continuous current exciter coupled direct to the shaft or by belt to the alternator; to start it up as a motor a continuous current from a storage battery is to be switched into the continuous current exciter, so that it acts as a continuous current motor and runs the alternator up to synchronising speed, and at the same times excites the

field of the alternator; synchronism having been thus obtained, the alternating current is switched on to the armature of the alternator, and the battery current switched off from the exciter. The alternator will now run on as a self-exciting motor, being excited in its field by the attached continuous current exciter, and in its armature by the alternating current.

Another method of starting up a synchronising motor is used by several makers of motors, and is simpler than the foregoing method. The construction is shown in diagram in fig. 1, in its simplest form. It resembles an ordinary Gris-

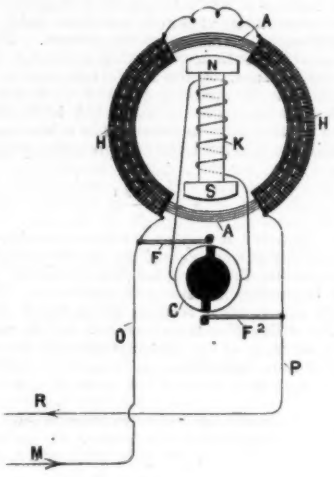


FIG. 1.

com motor, the field magnet, N S, rotates inside of the armature, A. H H are two armature coils. The field coil, K, is attached to a split tube commutator, C, which directs the currents into field coil, K. On turning on current alternating through leads, R M, this motor starts itself and runs up to synchronism, at which speed it is obvious that the current flowing in the field coil, K, will be a unidirection current pulsating; but the magnetic polarity is not reversed in the field at the synchronising speed. It will be seen that such a

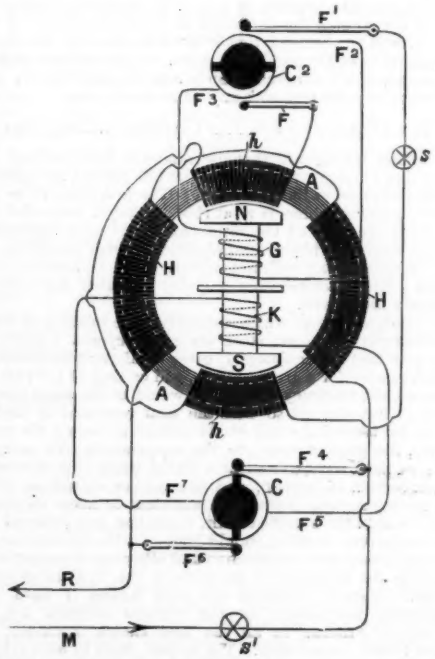


FIG. 2.

motor is simply a self-exciting alternator reversed. Alternators are commonly excited by redressing a portion of their own alternating current.

If we take such an alternator, in which a portion of its own current is shunted through the field coils by a rectifying commutator for the purpose of exciting the field, and reverse it by sending in an alternating current, it becomes a self-starting, self-exciting alternating motor, provided we make some necessary changes in the construction, such as laminating the field and making the dimensions of the cores and coils of field and armature, so that the self-induction in the field circuit is approximately equal to the self-induction in the armature circuit.

Of course the field exciting current pulsates about 50 per cent. ± in such a machine.

Zipernowski's motor (at least one of them) is operated on this plan. The author has also made that class of motor with success, and has improved it by exciting the field by two alternating currents in quadrature rectified, the one passed through one winding on the field, and the other passed through the other winding on the field.

Fig. 2 is a diagram of this motor in its simplest form, showing the field magnet, N S, wound with two coils, G and K, each connected to a split tube commutator, C and C^2. On the armature are the armature coils, H H, as in fig. 1, and also two smaller coils, h h^1. These smaller coils generate an alternating current, in quadrature with the main alternating current driving the motor. This is rectified, and goes to ex-

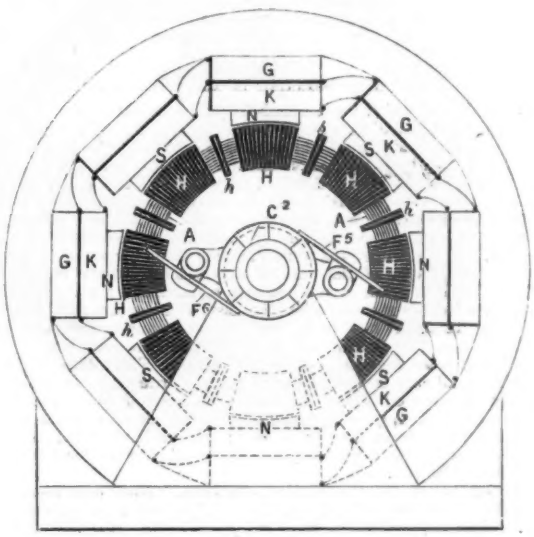


FIG. 3.

cite the coil, G, while K is excited by a portion of the main current rectified. By this method perfectly steady excitement is attained in the field when the synchronising speed is arrived at.

R M is the main alternating current leads. The coils, h h, for generating the exciting current in quadrature are shown large in diameter and short in length in this diagram. In practice they are wound symmetrically in one layer and of equal length over the core, each coil covering in this case of a two-pole motor about one-half of the core, the coils, h h^1, being on d diameter, at right angles to the coils, H H.

Fig. 3 is a diagram of a multipolar alternating motor of this description, as made by the author. G K are the two field windings, H h are the two armature windings, C^2 one of the commutators.

All these synchronising motors have sufficient power to start of themselves with a moderate load on, but they do not develop full power until the synchronising speed is attained.

The motor shown in fig. 3 makes a good commercial motor, to be worked on any ordinary alternating transformer circuit, and has all the efficiency both in plant efficiency and power efficiency of the reversed synchronising alternator. Many plans for starting synchronising motors have been proposed, but few have been of any use in practice.

Another class of alternator motor has occupied the thoughts and secured the attention of many electricians, in which no commutators or sliding contacts are required. It

is not easy to ascertain who first conceived the idea; but it is quite apparent that the invention which is to make it a practical success has not been brought out yet. The idea is to excite the field by an alternating current, and to produce current in the armature by induction only, these currents, flowing always in such a direction as to produce a torque in the one direction. We shall consider the form of motor further, with reference to what has been proposed as to their construction.

(To be continued.)

PROCEEDINGS OF SOCIETIES.

Institution of Electrical Engineers.

NOTES ON THE DESIGN OF MULTIPOLAR DYNAMOS.

By W. B. ESSON, Member.

(Paper announced to be read April 9th, 1891.)

THOUGH comparisons have frequently been made of the capabilities of machines having two poles and those having a greater number, I am not aware that the design of multipolar dynamos has yet received systematic treatment in any communication, or that a very satisfactory basis for comparison of the two types has up to the present been suggested. A perusal of the notes scattered about in technical journals, proceedings of societies, and text-books shows that the ideas on this subject are of the vaguest character, their expression having a most uncertain tone, and generally manifesting some erroneous notion. It is with a view of clearing the ground a little, and inducing some expression of correct ideas from members present, that these notes are brought before the institution.

1. PREVENTION OF SPARKING IN MACHINES GENERALLY.

In the paper which I submitted for your consideration 12 months ago, attention was directed to certain empirical formulæ relating to the armature loads for direct current machines. From the data furnished by a large number of examples, some of which were given in the paper, an expression for the load which could be safely carried by armatures without causing sparking was obtained; this expression, though admittedly of an arbitrary character, having been proved by my own experience, and that of my colleagues, to have been of some service. In that paper the term "ampère turns" was employed to denote the product of the number of conductors on the exterior of the armature and the current carried by each, and I am afraid this may have led to some confusion; at least, so it appears from the discussion. In order that there shall be no misunderstanding in the present case, I shall call this product, quite irrespectively of the number of poles, the *volume* of current carried. The volume is therefore the total current flowing parallel to the armature shaft, independently of direction and whatever the number of poles, and it is obtained by multiplying the conductors on the exterior of the armature by the current flowing in each; or, considering the exterior winding as a copper cylinder, it is the total current flowing in it parallel to the axis.

In his paper on "Armature Reactions," read here last year, Mr. Swinburne had worked out the limiting load from a theoretical point of view, and those who were present will remember that to obtain the results given in his paper the author assumed that the brushes were placed almost close to the polar tips. So far as the practical consideration of the subject goes, it matters little, I think, whether this is strictly accurate or not; because, while moving the brushes back from the tips increases the ampère turns producing the cross field, the magnetic resistance of the cross circuit is at the same time increased, due to the interposition of an increased air gap. For the moment, however, it will be assumed that the brushes are somewhere near the pole tips—in their vicinity, let us say—and that the only conductors concerned in producing the cross field are those covered by the pole pieces. This is sufficiently near the truth for our purpose. Under these circumstances the magnetising force in ampère turns producing a cross field is, of course, $\frac{v\,\phi}{360}$, where v is the volume, and ϕ the angle embraced by each pole piece in degrees. Call l the length of the air gap, measured from the surface of the armature core to the polar surface, and $\imath$ the induction per square centimetre which would be produced in the gap due to the field magnets alone. When a current flows in the armature the field is weakened at the pole tips nearer the brushes, and strengthened at those farther from them. Imagine that the armature is loaded so that the forward induction under the nearer pole tips is just balanced by the cross induction, and we have $\frac{v\,\phi}{360} = 2\,l \times \cdot 8\,\imath$, assuming that the components of the cross circuit, other than the air gap, have no resistance. According to this equation, with a value $v = \frac{576\,l\,\imath}{\phi}$,* the forward and cross induction at the pole tips would be equal, the field would be *nil* at the brushes, and, the machine being unstable, any increase of current would at once cause great sparking.

The above expression gives what might be called the theoretical load limit, on the assumption that no field is required for reversing the current in the sections as they pass the brushes, but it need scarcely be pointed out that in practice the volume is always much under what would be given by the formula. In the nature of things, one expects in the dynamos of different makers a considerable variation in the relation which the actual load bears to the limit above indicated, and such differences undoubtedly exist; but while one finds, on examining a large number of machines, several under, in few cases are there any having for v a greater value than half that given by the equation. This large margin must be considered in the light of a safety factor, for it would be folly to build machines the commutators of which would be liable to ruin by an occasional increase of current over the normal. No one expects machines to stand, in continuous working, a current of 50 per cent. over their normal output, for the rise in temperature would then be excessive; but, from the sparking point of view, this increase in a well-designed machine ought to make but little difference to it. Generally, the relation existing between the volume, gap dimensions, and induction in the best machines is expressed approximately by the equation,

$$v = \frac{288\,l\,\imath}{\phi} \qquad (1)$$

which gives, I consider, a very good rule for use in practical work. According to this, the working volume has about half the value expressing the absolute limit, this relation indicating the margin of safe working dictated by practice and experience. The formula expresses, in fact, an empirical relation which has a certain degree of flexibility. But with such a large margin it will be readily perceived that the strict accuracy of our assumption about the position of the brushes is of trifling importance, as is also our assuming that the whole of the magnetising force of the cross field is spent in the air gap.

It is easy to translate the above expression into the form I previously used for cylinder armatures. Call r the radial depth of the armature core, w the width of the pole piece, and $\imath_2$ the induction in the core. The induction, $\imath$, in the gap is $\frac{2\,r\,\imath_2}{w}$; and substituting for $\imath$ its value, we have

$$v = \frac{576\,r\,\imath_2\,l}{w\,\phi} \qquad (2)$$

Taking the induction in the armature core at from 17,000 to 18,000 C.G.S. per square centimetre, and inserting an average value of ϕ, we get for bi-polar Gramme-wound machines the expression,

$$v = \frac{r\,l\,85{,}000}{w} \qquad (3)$$

which I had used for some time, and which was given in my last year's paper. This is only a rough approximation, for, as Mr. Swinburne has pointed out, to be quite accurate, the angle should appear in the denominator as in (1) and (2). The simplest form the expression can take is given in (1). This contains nothing but the length of the air gap, the induction in it, and the angle of the pole-piece. It will be observed that it takes no notice of the diameter of the armature or of the number of poles. So far as the sparking limit is concerned, it gives a rule which may be employed in designing machines of any size and with any number of poles.

2. THE RELATION OF v TO THE DIAMETER OF THE ARMATURE.

But besides taking care that the armature load does not approach the sparking limit, we must provide ample surface for getting rid of the heat generated in the conductors. The first thing to be settled in designing a new machine is what this amount of heat shall be; or in other words, we must fix the ratio which the energy appearing at the terminals shall bear to the total electrical energy produced. Having settled this, sufficient radiating surface must be allowed to prevent too great a rise in temperature—a point to which due consideration has already been given.

The principal factors which determine the relation of the volume to the diameter of the armature are efficiency and temperature. It will be seen that the equation (1) gives no direct information respecting the diameter for a given volume, and as long as $\imath$, l, and ϕ remain unchanged, the tendency to sparking would be the same whatever the diameter. But it is not so with the heat generated or the temperature rise, for assuming v and l to be related as shown, the smaller the diameter, the greater would be the temperature. To carry a given volume we must have, consistent with the waste of power permissible, a certain section of copper; and this copper should be disposed so that a cooling surface is provided sufficient to keep the rise in temperature within the specified limit, while the gap, being of sufficient length to prevent sparking, should have only the dimensions necessary for accommodating the conductors and allowing of proper clearance.

Through the kindness of members of the Institution and others, who have liberally supplied me with figures, I have been able to ascertain the nature of the relation between the diameter and volume existing in all the best known machines, from the smallest to the largest sizes. The figures refer to both cylinder and drum-wound armatures, and include machines with two, four, six, and eight poles. Though I am not at liberty to publish the data in full, the general results are given. There is not so much agreement between the dynamos of different makers in respect to this relation as might have been expected, and for v we have all kinds of values, ranging from 200 to 1,000 times the diameter of the armature in centimetres. If full advantage of the length of the air gap were

* I have pointed out to Mr. Swinburne that the equations $A = \frac{10\,b\,g\,B_a}{\theta^2\,r}$ and $A_2 = \frac{10\,B_a\,r\,B\,l}{w^2}$ which he gave last year on p. 266 of his reply ought to be $A = \frac{5\,b\,g\,B_a}{\theta^2\,r}$ and $A_2 = \frac{20\,B_a\,r\,B\,l}{w^2}$ respectively. In looking over his paper and reply Mr. Swinburne finds other slips which he will probably correct as discussion on the present paper proceeds.—W. B. E.

taken, and the thickest possible conductor used in each case, the diameter, to give a uniform temperature for all sizes, would be about proportional to the square root of the volume, but there are several reasons why this proportion should not obtain in practice. With this relation the ratio of the stray to the useful field would increase with the diameter, thus entailing an extravagant expenditure of energy in producing the requisite gap induction. Again, while the total field through the armature would increase simply as the diameter, the volume carried would increase as the *square* of the diameter, this being at variance with the well-established rule that the total field through the armature increases rather than diminishes relatively to the volume as the size is increased. It will be understood, of course, that precisely the same result is arrived at whether we consider the volume fixed and endeavour to find the best diameter, or consider the diameter fixed and seek for the best volume. It is simply a question of obtaining the most economical construction, having regard to cost of materials, efficiency, prevention of sparking, and temperature limit, though the figures at my disposal show estimates of the relative values of these factors to be by no means uniform.

Though the relation lacks definiteness to some extent, I find in the data of a large number of machines indications sufficiently pronounced to justify us in regarding the volume carried by the armatures of two-pole dynamos as proportional to the diameter for all sizes. In designing cylinder machines the value of v may be taken as 400 times the diameter of the armature in centimetres, while for drum armatures the volume is obtained by multiplying the diameter by 600.* The cylinder armature has for a given volume a larger diameter, because of the influence of the interior wires. These being heaped inside to one and a half or twice the depth of the exterior winding, also being longer, a larger diameter is required for a given volume, both from efficiency and temperature considerations. Necessarily, the relations here given are not of a hard-and-fast character, and may be varied considerably. But whatever the proportion adopted, it is absolutely essential that the sparking limit already considered be not too closely approached.

In machines having four and six poles the same average relation between the volume and diameter holds in practice for both cylinders and drums. In the calculations which follow these figures will therefore be adopted.

3. Output of Direct Current Armatures.

If we call N the total number of lines of force entering the armature from all the poles, however many, and n the number of revolutions per second, the average E.M.F. generated in each conductor is, of course, $\mathrm{N}\,n\,10^{-8}$. If C be the total current flowing, each conductor will carry with the sections coupled in the ordinary way $\frac{\mathrm{C}}{\mathrm{P}}$ ampères, p being the number of poles. The electrical work due to each conductor, is $\frac{\mathrm{C}}{\mathrm{P}} \times \frac{\mathrm{N}\,n}{10^8}$; and the total work, $\frac{w\,\mathrm{C}}{p} \times \frac{\mathrm{N}\,n}{10^8}$, where w is the number of conductors, counted all round the exterior of the armature. The quantity $\frac{w\,\mathrm{C}}{p}$ is what we have called the *volume*, and we get for the total electrical output in watts the expression,

$$\mathrm{W} = \mathrm{N}\,n\,v\,10^{-8} \qquad (4)$$

which is quite independent of the manner of coupling up the armature sections. It will be evident, I think, that with the same relation existing between v and d for two, four, and six poles, the output of an armature of given diameter and length, running at the same speed, is quite independent of the number of poles. It matters not whether N be furnished by two poles only, or by four poles of half the angular width provided its value remains unaltered.

The volume, then, may be expressed in terms of the diameter. The quantity, N, may be expressed in terms of the diameter × length of the armature. Taking an induction of 5,000 C.G.S. units per square centimetre in the air gap—a very usual figure—and assuming that the fraction of the armature circumference covered by the pole pieces = 2·25 d, we get, calling L the length of the armature in centimetres, 11,250 $d\,L$ as the total number of lines of force entering the core. Call this, in round numbers, 12,000 $d\,L$. Substituting for N and v their values, the output becomes for cylinder armatures

$$\mathrm{W} = \cdot 048\, d^2\, L\, n \qquad (5)$$

and for drum armatures

$$\mathrm{W} = \cdot 072\, d^2\, L\, n \qquad (6)$$

This applies to all direct-current machines, whether bi-polar or multi-polar; though it will be understood, of course, that the induction in the gap may be greater or less than what has been assumed. In that case the coefficients ·048 and ·072 would be altered, without changing, however, the form of the expression.

4. Output of Alternating-Current Armatures.

The armature loads for alternators, though producing a cross magnetisation, as in direct-current machines, raise no considerations, of course, as regards sparking. But on account of the greater proximity of the poles, and the greater stray field resulting, it is desirable to make the layer of copper on the armature core as thin, and the air gaps as short, as possible. As a consequence, probably, of the increased ratio of stray to useful field, the induction is less in the gaps of alternating than in those of direct-current machines. Here it will be assumed that the virtual induction is 4,000 C.G.S. units per square centimetre, meaning that this represents the induction to which the resultant E.M.F. is due. The impressed E.M.F. is greater than the resultant, and the induction due to the field magnets alone is greater than 4,000; but what I am dealing with is the field resulting from the inter-action of the magnet and armature fields: it is the field to which the resultant E.M.F. = $\mathrm{C}\,\mathrm{R}$ is due, this and the current being coincident in phase. Usually the poles cover a fraction of the circumference = 1·5 d, the value of N for alternators being then 6,000 $d\,L$. About half the circumference being covered with wire, under usual conditions of temperature and efficiency we have for v a mean value of 400, which gives for the product of mean resultant E.M.F. and mean current = ·024 $d^2\,L\,n$. In some cases, as in the Westinghouse machine, the conductors cover considerably more than half the circumference, and v is therefore greater. But here, on account of the differential effect produced on the separate wires of the same section, the added turns have nothing like a proportionally increased value, and the expression will give approximately the value of the product of mean resultant E.M.F. and mean current, even in these machines. Assuming that the E.M.F. is a sine function of the time, to get the watts we must multiply by $\frac{\pi^2}{8}$, which gives us, therefore, as the output of the alternator

$$\mathrm{W} = \cdot 0296\, d^2\, L\, n \qquad (7)$$

or rather over 40 per cent. of the work done by a drum wound direct current machine having an armature of the same external dimensions.

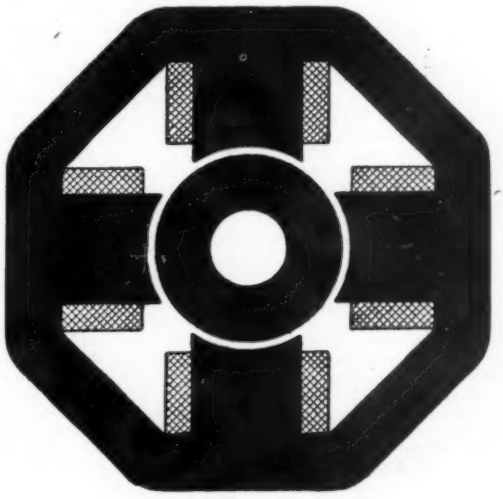


Fig. 1.

Some comparisons have been made of the output of direct and alternating machines of the same weight, but these, in the nature of things, must be misleading. The two types are quite unlike in their proportions, as figs. 1 and 2 show, and no one would think of making them the same. Fig. 1 represents the magnetic system of a four-pole

Fig. 2.

direct and fig. 2 that of a 12-pole alternating machine of the same output; and while it will be observed that the iron parts—core and yoke rings—are much heavier in the former, it will be noticed that the copper in the magnet coils is much heavier in the latter. In fact, though the iron in the alternator is only 55 per cent. of that in

* In my last paper the number given was 570. This I now amend as above.—W. B. E.

the direct current machine, the copper required is no less than 150 per cent. It is difficult, then, to understand what useful purpose is served by comparisons such as I have alluded to.

5. Relation of Air Gap to Diameter of Armature and Number of Poles in Direct-Current Machines.

Having established the proportionality of the volume and diameter, it is easy to find the relation which must exist between the diameter and length of air gap for any particular angle of embrace, in order that sparking may not occur. I need not take up time ringing changes on the several equations, as to obtain the relation now referred to, all that has to be done is to substitute for v in (1) its value in terms of the diameter accordingly as the winding is of the cylinder or drum type, and find the connection between l and d. Preserving the same safety factor throughout, it will be found that two-pole dynamos with a mean gap induction of 5,000 C.G.S. units per square centimetre, and pole pieces embracing an angle of 130°, must have—the volume being related to the diameter as described—gap of not less than ·036 d if cylinder-wound, or ·054 d if drum-wound. As will have been observed, the air gap may diminish as the induction is increased or as the volume is reduced.

But, as is also seen from the equation, the gap required for any particular volume is proportional to the angle of embrace, and if we substitute for two poles a greater number of correspondingly less angular width, working with an increased diameter and volume without a proportionally increased gap is made possible. This is where the advantage of the four, six, or even eight-pole machine comes in. Keeping to two poles, increasing the diameter requires either a proportional increase in the gap, whether the space is required for the conductors and clearance or not, or an increased induction, or a diminished polar angle, or a combination of these. In either case, the magnetising force spent in the gap is increased; and, other things remaining the same, obviously it would be of some advantage to adopt a construction which, while producing no greater tendency to sparking, would admit of the air gap being reduced until its length was just sufficient to accommodate the conductors and allow of the necessary clearance. The work done by an armature of given external dimensions we have seen to be quite independent of the number of poles, and the choice of this number can only be a question, therefore, of structural and working economy.

6. Dimensions of the Armature.

It has been observed that the output of an armature is proportional to $d^2 L$; and the induction being the same, the weight of the core for a given number of poles must be proportional to the output, the radial depth increasing directly as the diameter, so that a proportionally increased field may be carried. The number of poles being fixed, the weight of the core for a given output may be taken, therefore, as approximately constant, whatever the ratio of L to d.

As the number of poles is increased, the induction remaining the same, the radial depth of the core is diminished in proportion, and, within the limits of practice, we may make the further assumption that the weight is inversely as the number of poles. The money value of a reduction in the weight of material due to increasing the poles can easily be arrived at.

The power wasted in hysteresis is proportional to the weight of iron magnetised, and to the number of reversals per second. The weight being inversely, and the reversals directly, as the number of poles, the power wasted is for a given output the same; furthermore, as the output is proportional to the speed, we may say that for a given induction the loss in hysteresis is about proportional to the output only, without reference to speed of rotation, weight of core, or number of poles. If it be more important to reduce the loss by hysteresis than to reduce the weight of material, it can, of course, be done. It is a point for the designer to consider.

So much for the core; let us now consider the copper part. Taking Gramme-wound armatures having an interior opening equal to ·66, or two-thirds of the core diameter, it is found—the output, speed, and temperature being predetermined—that the ratio of L to d may vary through a considerable range without making any great difference in the weight of copper or efficiency. For instance, the most efficient relation being $L = \frac{d}{3}$, it may be varied on the one hand till $L = d$, or on the other till $L = \frac{d}{6}$, without increasing the copper by more than about 10 per cent. Of course the watts wasted in the armature are correspondingly increased, but within the limits of the large variation mentioned, the reduction in the electrical efficiency of the machine is under one-half per cent. In two-pole machines L varies from ·5 to 1·5 d, the normal relation being about $L = d$. As has been seen, the gap has to be increased in proportion to the diameter, unless a greater number of poles be employed; and the disadvantage of an increased magnetising force would, in machines with only two poles, counterbalance the slight advantage of getting the armature dimensions nearer the best proportion. When the poles are increased, however, the gap may remain fixed, and if the radial depth of the core be correspondingly diminished, the proportions for least copper and highest efficiency are altered: thus in a four-pole Gramme we can work from $L = \frac{d}{3}$ up to $L = \frac{d}{12}$ without a greater variation than 10 per cent. in the weight of copper. Observe, this is a question differing altogether from the one which was considered in my former paper. In that case the length and radial depth of the armature over the winding were fixed, the problem then being to find the best relation of copper to iron. Here both radial depth and length of core alter, also the peripheral velocity, though the revolutions per minute remain the same. Why the velocity is allowed to alter will be immediately apparent; I only show at the moment that the dimensions of the armature may have their relations altered considerably without making any considerable difference to the weight of copper or efficiency.

To the drum-wound armatures precisely the same reasoning applies. Here, speed and temperature being fixed as before, the best proportion for two-pole machines is about $L = 3{\cdot}3\ d$; but because of the distance between the bearings which such a relation would necessitate being inconveniently great, we rarely find $L = 2\ d$ exceeded. The latter requires about 5 per cent. more copper than the former, while for the usual proportion, $L = 1{\cdot}5\ d$, 12½ per cent. more is required than for $L = 3{\cdot}3\ d$. The variation which can be made without overstepping the limits of economy has a smaller range in drum than in cylinder machines, owing to the greater relative importance of the end wires, because of their greater length. If the length of the core is reduced below $L = 1{\cdot}5\ d$, the copper in machines with two poles increases rapidly; but if the number of poles be increased, the length of the end wires being shortened nearly in proportion, the core length may be reduced to a fraction of the diameter without sacrifice of copper or efficiency. In a four-pole machine, for instance, the same copper is used with $L = {\cdot}5\ d$ as in a two-pole one with $L = 2\ d$; while for six poles, without increasing the copper, the relation may be as small as $L = {\cdot}25\ d$. The effect of adding poles when the diameter is relatively great is not so noticeable in Gramme-wound machines, as the end wires are less important.

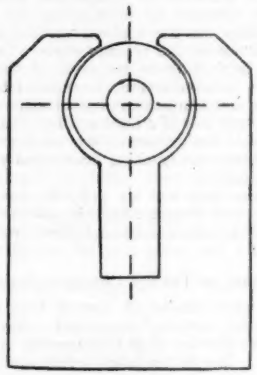


FIG. 3.

All the above facts go to prove that if there is anything to be gained, as regards the production of the field, by increasing the diameter of the armature and the number of poles, there is nothing, considering the armature by itself to be lost by it. It may, in fact, be rather an advantage, because the weight of the iron core is reduced. It is true the peripheral velocity is increased; but this does not matter in the least, provided a certain limit is not exceeded. Opinions differ as to what the limit should be, some machines working at 50 feet per second, others at 100, and a few as high as 125. But there is no reason whatever why any properly constructed armature should not run at a periphery speed of 100 feet per second; and provided this velocity is not exceeded, any advantage which may be obtained by a relatively large armature and increased number of poles should be secured.

7. Dimensions of the Field Magnets.

It will be apparent, from the foregoing considerations, that the employment of two, or more than two poles for direct current machines of moderate dimensions resolves itself mainly into a de-

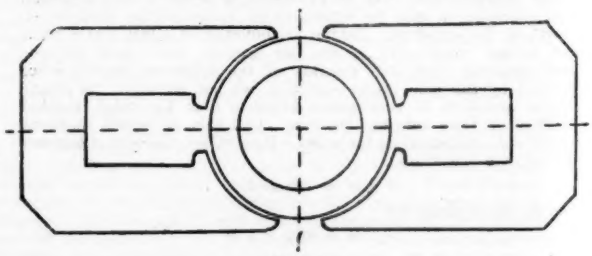


FIG. 4.

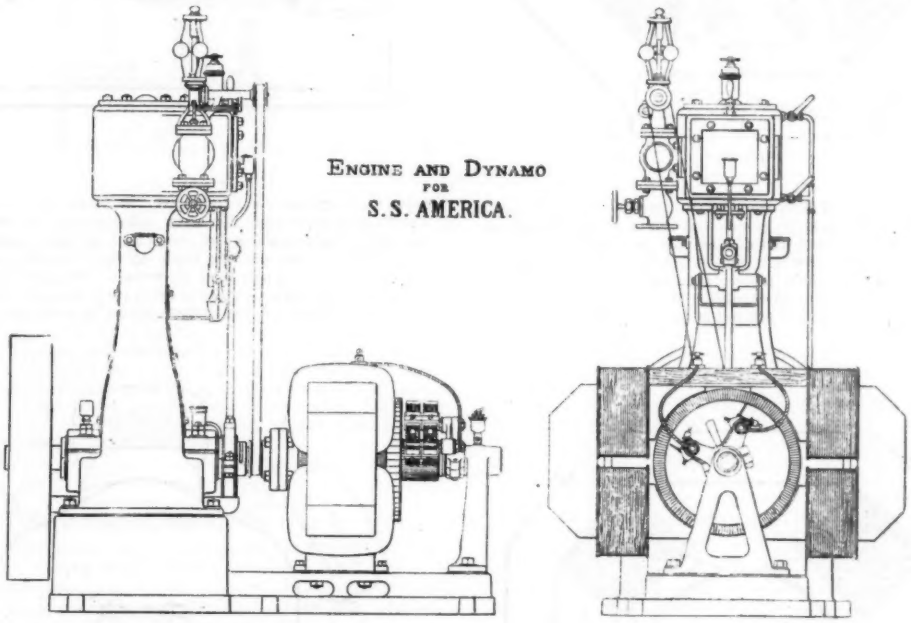
liberation regarding the most economical shape to give to the field magnets. As regards the armature, considered by itself, we may say that the choice of dimensions is mostly a matter of convenience, seeing that the amount of copper required and efficiency are for a given output practically unaltered by variations in this respect, while the reduction in the weight of the core due to an increased number of poles is to some extent compensated by the extra expense of larger plates and increased weight of the armature supports. Again, the cost of labour is increased by the larger diameter; but, everything being taken into account, considerations respecting the armature do not influence the design to a very great extent. One thing in favour of increasing the poles, as far as the armature is concerned, must, however, be remembered, and that is the reduction, consequent on a smaller conductor being used, of the losses arising from parasitic currents. We now turn our attention to the magnets.

I have said that for the prevention of sparking it is necessary that, the induction per square centimetre remaining the same, the air gap

increases proportionally to the diameter, whether the space is necessary for conductors and clearance or not, but that the coefficient by which the diameter has to be multiplied to give the length of the gap necessary to prevent sparking diminishes directly as the pole angle. In comparing the magnetic system of a four or six-pole machine with that of a two-pole one, it is necessary to adopt dimensions for the armature in accordance with the considerations already mentioned; hence, if the two-pole armature had a length of core equal to one and a-half times its diameter, in a four-pole one the length should be about half the diameter. The diagrams (figs. 3 and 4) show the cross sections of two such machines. The diameter of the four-pole armature is 1·4, and its length ·5 times that of the two-pole one, consequently both machines give the same output. The weight of the two horseshoe magnets in the four-pole machine comes to 56 per cent. of the weight of the single horseshoe magnet, which indicates in this particular case a considerable saving in wrought iron. In taking the copper weight it is necessary to bear in mind that this does not vary simply as the length of the wire if the machines are of the same efficiency, but as the square of the length; so in this particular comparison the copper on the two horseshoes would be, roughly, 30 per cent. more than on the single horseshoe, assuming the length of the air gaps to be the same. Now, if it were possible to reduce the gaps by 12 per cent. or so, the copper weight would be similar in both machines, and we should have credit for a certain amount of iron saved in the construction of the four-pole one, which could be balanced against the increased expenditure for labour. If the gap can be reduced by more than 12 per cent.—always retaining the depth of the winding the same—there is a saving of copper as well as iron, and it is simply the comparison between the value of the copper and other materials used and the cost of the labour in the two cases which determines, at least in machines of moderate size, whether two or more poles should be adopted.

In getting out the best relation of L to d in the different types of armatures, it is assumed, of course, that, the volume being proportional to the diameter, the depth of the winding remains unaltered, as that is the condition which gives uniform rise in temperature. Accordingly, for a given output, the layer of copper on the armature will be of the same depth, whether the machine has two poles and an armature having a length of one and a half times its diameter, or four poles and an armature having a length of only half the diameter. But whether it is possible to reduce the gap to an extent which, with an increased number of poles, will lead to a less costly construction, is a question which, for machines of moderate dimensions, must receive careful consideration in each individual case. The answer depends upon how much larger the gap has to be to prevent sparking in the case of two poles only, than is requisite to accommodate the conductors and allow the necessary clearance. If the difference is considerable, it may pay better to add poles, and reduce the gaps that way, than to do the same thing by diminishing the pole angle or increasing the induction, or both. The question, it appears, is answered in different ways by different people. It is somewhat interesting to note, for instance, that one engineer, distinguished for the past six years as an ardent advocate of multipolar machines, has, after reducing from six poles to four, lately arrived at two, while another has jumped straight away from two to six without a halt at the intermediate number.

But when we come to machines of a certain size there is undoubtedly a gain in employing more than two poles, while very large machines become impossible of construction with two poles only. Consider the case of a two-pole armature of 60 centimetres diameter. Assuming the induction in the gap to be 5,000 C.G.S. lines per square centimetre, and the pole angle 130°, our calculations show that the length of air gap would require to be 3·24 centimetres. This is some 40 per cent. in excess of the requirements of conductors and clearance; so, if the gap is reduced until it just allows of the requisite clearance, the induction must be increased from 5,000 to 7,000. Keeping the output of the machine the same, however, we can reduce the diameter of the armature to 54 centimetres, and work with an induction in the gap of 6,500. Observe, the magnetising force spent in the gap has now been reduced by about 7 per cent., but the total field through the armature has been increased by 15 per cent., and the induction in the armature per square centimetre by more than 25 per cent. If we retain the same section of iron in the fields, it may be assumed then that about the same total magnetising force is required, whether the machine has an armature 60 centimetres diameter, with a gap induction of 5,000 C.G.S. units, or one 54 centimetres diameter, with a gap induction of 6,500. The latter might turn out to be impossible, owing to the greater heating of the armature core; any way, what I am attempting to show now is, that by pressing up the induction with a view of reducing the gap, little, if any, advantage is obtained. But by increasing the number of poles, and reducing the gap in that way, we effect, without increasing the gap induction, a marked economy. As it is unnecessary to go into a mass of figures to prove what each can readily prove for himself from the data already before you, I will just give here the results. If we substitute for the two-pole armature of 60 or 54 centimetres diameter and 90 centimetres long a four-pole one of 84 centimetres diameter and 45 centimetres long, with a gap induction of 5,000, we require for the magnetising coils while working at the same sparking limit, and with the same efficiency, rather under 70 per cent. of the copper on the two-pole field. When to the saving in copper there is added the saving in iron, there will be, after the extra labour is debited against the four-pole machine, a considerable balance in its favour. But to go beyond four poles in this case would be a mistake. Increasing the poles always results in an actual increase of copper, unless at the same time the power spent in the gap is reduced, and this latter must be effected without reducing the thickness of the armature winding. The economy shown above is simply due to the fact that, in a two-pole machine of the dimensions specified, the gap necessary for the prevention of sparking must be much larger than the conductors require unless pressed up to a high induction. If with four poles the gap is still larger than necessary, we go to six poles, and so on. But when we arrive at a point where increasing the number admits of no reduction in the gap, we go no farther. It may be mentioned, however, that even in sizes where a four-pole construction showed no actual economy in first cost, it might still be preferable to the two-pole on account of its symmetrical field and the absence of magnetic pull.



ENGINE AND DYNAMO FOR S.S. AMERICA.

FIG. 5.

Having discussed the design of multipolar machines as influenced by both theory and practice, it remains to conclude this communication by calling attention to some of the ordinary forms of multipolar fields. The double wrought iron horseshoe (fig. 4) is not very frequently used, being rather costly; but a similar machine with magnets of cast iron, lately made by my firm for the National Line ss. *America*, is shown in fig. 5. The armature core in this case was formed by winding square annealed iron wires on a gun metal flanged cylinder. The winding was of the Gramme type, and the machine was coupled direct to an inverted engine, as shown in the fig. This

design, introduced by Gramme in 1869, generally gives place to the arrangement shown in fig. 6, a form designed by the same inventor in 1885, and since adopted for cylinder-wound armatures by many makers, including Mr. Jáspar, in Belgium; Mr. Brown, of the Œrlikon Works, in Switzerland; and Messrs. Paterson and Cooper, in England. Lately Mr. Kapp has used the same form for six and eight-pole machines with drum armatures. The magnets and octagonal yoke in fig. 6 are of cast iron, in two pieces, the lower limbs, the bottom half of the yoke ring, and bed plate being one casting, and the top limbs and upper part of the yoke being another. Fig. 7 represents a similar field in which the magnet cores are of wrought iron, fitted with cast iron pole pieces, as used by Mr. Kapp in the machines above mentioned. The decision as to whether cast iron or wrought iron should be used is arrived at in a very simple manner—

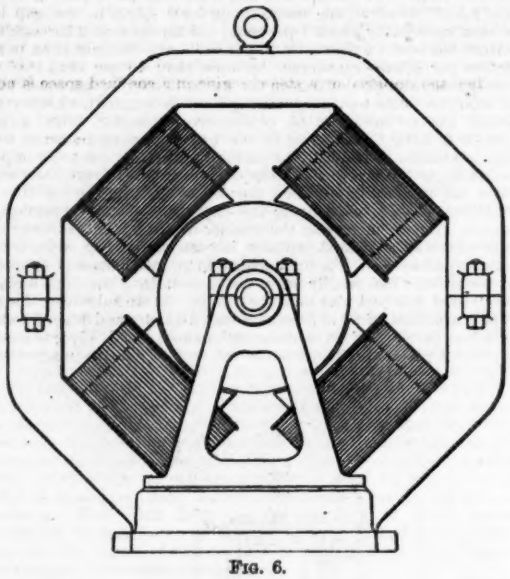


FIG. 6.

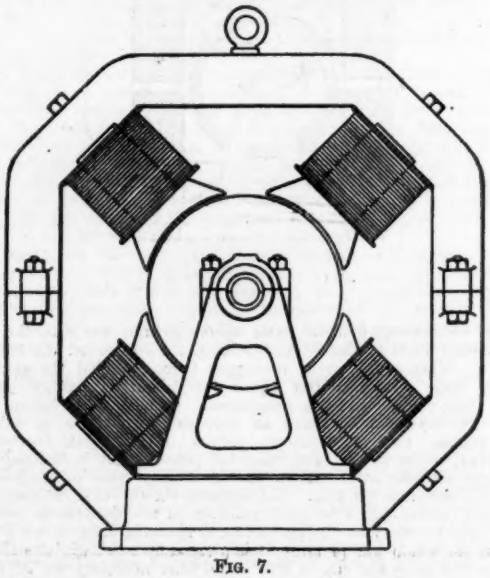


FIG. 7.

by comparing the excess of copper required on one hand with the extra machining required on the other.

It will be observed that in the designs figs. 6 and 7 the yokes are considerably longer than those shown in fig. 4; and the weight of the former, if made of the same material, would be, roughly, twice that of the latter, though even then the complete magnet system would be but 75 per cent. of the weight of fig. 3. The yokes being of cast iron, however, the system really comes about 20 per cent. heavier than fig. 3; the less expensive character of the material compensating, of course, for the increased weight.

All these are examples of single magnetic circuits, where the lines of force from each pole remain undivided in their paths through the magnetising coils; but in figs. 8 and 9 are shown examples of double magnetic circuits, in which the lines from each pole take two paths through separate coils. Fig. 8 is a type of magnet used by Sautter-Lemmonier, of Paris, for Gramme-wound armatures, and by Cuenod-Sautter, of Geneva, for armatures having a Siemens winding as modified by Thury. The magnetising coils are wound upon the parts of the system constituting in fig. 7 the yokes, and a greater amount of copper is in consequence required. It looks at first sight as if the weight of copper were not very different in the two types, but in this respect appearances are deceptive, for, as a matter of fact, the field of a four-pole machine made to fig. 8 would require about 125 per cent. more copper than if made according to fig. 7. It will be observed, however, that the magnet cores and pole pieces, which are made throughout of the softest wrought iron, are very light. In

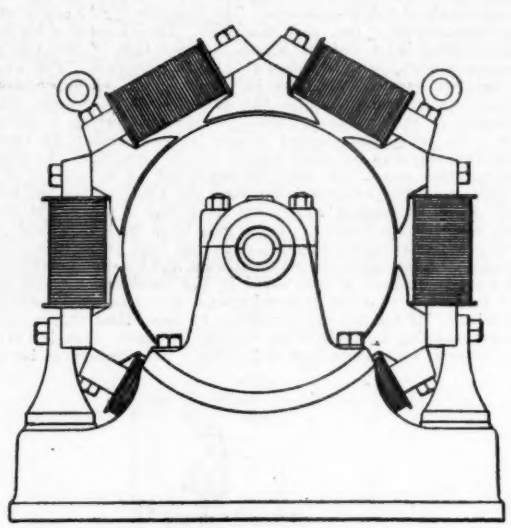


FIG. 8.

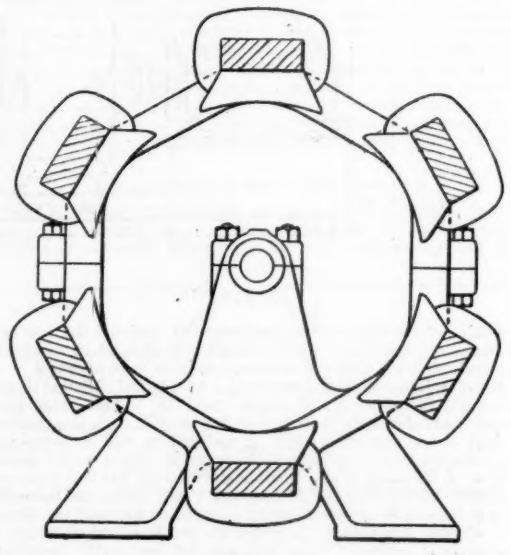


FIG. 9.

fig. 9 the magnets are a series of wrought iron bars lying parallel to the armature, each fitted with a cast pole piece in the middle of its length, and having two magnetising coils, one on each side of this piece. It is a structure which may be frequently met with, though not precisely in the form shown, and the observations regarding the copper made with reference to fig. 8 apply equally here.

The cost of a four-pole machine is approximately represented by the cost of a couple of two-pole machines of the same efficiency, which give each half the output at twice the speed; the cost of a six-pole by that of three two-pole machines which give one-third of the output at three times the speed and so on. For comparison, the fields must be in both the multipolar machines and two-pole machines

of the same character—that is, with single or double magnetic circuits.

The fields of alternators may be similarly divided into those having single and those having double magnetic circuits; the former requiring, as in the fields of direct current machines, much less copper than the latter. Amongst those having single magnetic circuits are the machines of Siemens, Ferranti, Mordey, Westinghouse, Elwell-Parker, and Paterson and Cooper. Mr. Kapp possesses the distinction of having the only alternator with double magnetic circuits. The "Phœnix" alternator, shown in fig. 10, possesses some features which may be of interest, as illustrating the way in which the commercial aspect of designing has to be considered. The yoke-ring is of cast iron, but the magnets are of tooled wrought iron, shaped as shown. If the magnets had a breadth equal all the way up to the length of

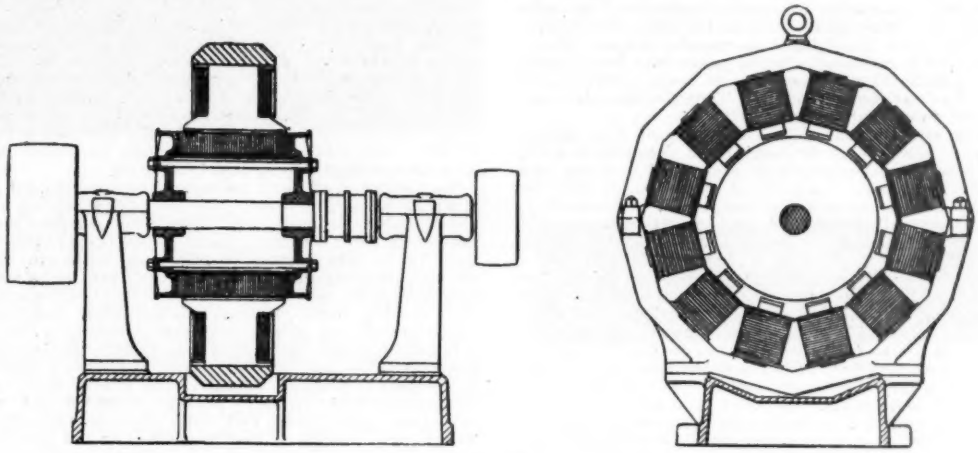


Fig. 10.

the armature core, they might as well have been of cast iron, for the little advantage consequent on the reduction of copper obtained by narrowing them would not have paid for the extra work in tooling wrought iron. But when we reduce the breadth where the magnetising coils are, as shown, we at once diminish the copper on the fields by 60 per cent., greatly reduce the leakage area, and get a good balance after paying for extra tooling. The machine, as will be seen, has 12 radial magnets, and there are on the armature six flat coils, each equal to three times the width of the magnet cores, and laid on the periphery with a space equal to the core between them.

The length of the paper prohibits me from dealing with many special types of machine, to which, however, all the reasoning here used may be applied without difficulty.

Royal Scottish Society of Arts.

Electrical Navigation. By A. R. Bennett, member of the Institution of Electrical Engineers.*

One of the chief features of the Edinburgh International Exhibition of 1890 has been the first practical demonstration of electrical navigation in Scotland, a demonstration which is due to the enterprise of the General Electric Power and Traction Company in placing a flotilla of electric launches on the Union Canal.

On the Union Canal electrically propelled boats have, I believe, for the first time in history, plied for hire at twopenny fares, just like so many steamers or omnibuses, and so have been open to everybody.

It is gratifying to be able to state that they have met with a very generous measure of support. The terminus at Edinburgh, situated in a side street of not too savoury a character, has militated much against the traffic, while the almost continuous wet weather has naturally deterred people from travelling in open boats; but notwithstanding all adverse circumstances, the launches have constituted one of the most attractive features of the exhibition, and have carried, from May 31st until October 11th, no less than 71,075 paying passengers, besides season ticket holders, officials, and others entitled to travel free. The busiest day was the Edinburgh autumn holiday, when 2,560 passengers availed themselves of the novel mode of transit.

The first experiment in Scotland in electrical navigation may therefore be set down as a pronounced success, and it is to be hoped that the ball set rolling will not be allowed to rest, and that next year will see electric launches on several of our rivers, lochs, and firths.

Before referring in detail to the flotilla on the canal, I may be permitted, perhaps, to touch briefly on the advantages of electric launches in general.

In designing any boat required to operate safely, economically, and conveniently, several points have to be kept in view. This is especially true of passenger boats, because the cargo in that case has not only to be stowed safely and compactly, but comfortably. When steam is the motive power, these two last considerations have to be, in a degree, sacrificed. The boiler and engine, with the necessary fuel, occupy space, perhaps not in the aggregate of greater cubic measurement than that wanted for accumulators and motor of corresponding power, but space that requires to be of a certain shape and to be in a certain position, so that while the accumulators can be stored out of sight under the seats, in recesses that would be untenanted and useless in a steam launch, the boiler, engine, and fuel occupy a part of the boat that would be available for passengers if it were not for their presence. A steam launch, therefore, to carry an equal number of passengers, must be at least 25 per cent. larger than an electric one. This means a saving of some moment in first cost, and a perpetual saving in working expenses, for there is some 25 per cent. less of useless dead weight to propel wherever the vessel goes.

Then the presence of a steam engine in a confined space is not calculated to promote the pleasure or comfort of the passengers. There is a certain amount of smell, of smoke, of dirt, and of noise inseparable from the best steam engine, while the vibration due to the unequal action on the crank shaft—to which motion is imparted by a succession of jerks—is much greater than with an electric boat, the shaft of which receives a smooth, regular, rotary impulse from the motor. Then steam—faithful servant as it is—is not quite devoid of danger, especially when under amateur management. An electric launch might be mismanaged to the extent of rendering it temporarily useless for the purpose of loco motion, but under no circumstances could any injury derived from the machinery or batteries happen to the passengers. I have deemed it desirable to mention this, because it is within my knowledge that persons have avoided the electric launches in Edinburgh, some from fear of receiving shocks, and others out of unnecessary consideration for their watches, which they expected would get magnetised. I need scarcely tell this society that, as the boats are arranged, both fears are entirely illusory.

In other respects the electric boats possess advantages. For instance, one man can steer and work the motor, a feat difficult to perform satisfactorily when furnaces have to be fired and gauges watched. There is no boiler to insure or to be inspected periodically. In fact, while a steam launch takes her power on board unmade, in the form of coal, and manufactures it as she goes along, an electric launch receives her's prepared and ready for use, available at any moment and in any desired quantity by merely turning a tap.

Electric launches are suitable for other purposes than pleasure or carrying passengers. The company has supplied one to the Spanish navy, and when one considers how useful such a vessel must be in connection with a ship of war, it appears strange that the British Admiralty should allow the Spaniard to show them the way in such a matter. Our ironclads are nearly all equipped with the electric light. Their dynamos during the day could charge the accumulators of launches suspended from the davits, so that each ship could let down into the water at any moment several launches with their power ready stored for a six or eight hours' run. The accumulator in the launches, when not needed for propulsion, could supplement, or, in case of need, assist, the lighting of the ship at night; or they could work windlasses, or pumps, or ventilators.

All the launches on the Thames are built of wood; those on the Union Canal are of steel. They are four in number, and are named *Theo, Flo, Hilda*, and *May*, after the daughters of Lord Bury, the chairman of the General Electric Power and Traction Company. The hulls were designed by Messrs. Morton and Williamson, Glasgow, and built by Seath and Co., Rutherglen. They measure 40 feet long over all, 6 feet beam, 3 feet 1 inch from gunwale to keel, and draw 2 feet 1 inch of water when empty. Equipped with motor and accumulators, they weigh 3½ tons out of water. They are licensed by the Board of Trade to carry 40 passengers, and seat that number easily.

They carry 50 accumulator cells of the E.P.S. boat type, manufactured by the Electrical Construction Corporation, of a capacity af 120 ampère-hours. They require a charging current of from 30 to 40 ampères, and discharge up to 40. The cells have 15 plates each (7 positive and 8 negative), measuring 6⅞ inches deep (8 inches top, 7$\frac{15}{16}$ inches bottom), 6⅝ inches deep (8¼ inches top, 7½ inches bottom), and contained in ebonite jars, which, like the plates, are tapered off

* Abstract of paper read at the special meeting held in the Edinburgh International Exhibition, October 13th, 1890.

on one side, so as to adapt themselves readily to the shape of the boat. The weight of a complete cell is 58 lbs. The cells are ranged along the sides of the launch in two rows of 25, protected by boxes, the lids of which, when covered with cushions, form the passengers' seats. The cells are kept well apart, and stand upon glass insulators, filled with resin oil. This is an altogether unnecessary precaution, however, with ebonite boxes, although a very desirable one with wood. No arrangement of glass insulators could save a current capable of leaking over 13 inches of ebonite. The boxes containing the cells are well ventilated, so that the gas given off from the cells while charging cannot become stored up. Except when charging there are no fumes from the accumulators; then the only emanations are oxygen and hydrogen, which are innocuous.

The accumulator plates are of the grid pattern—that is to say, they are composed of leaden frames, which carry the active pastes in a multitude of small square holes. The exact composition of the pastes used is known only to the makers, but in all probability the positive paste is mostly minium ($Pb_3 O_4$) and the negative litharge (Pb O). The plates are said to be formed, after the pastes have been applied to the grids, by giving them a charge for 60 hours in a solution of sulphuric acid, of specific gravity 1·18. Thereafter the plates are dipped in warm water, scrubbed, and dried.

The solution used with the cells is originally of 1·18 specific gravity; this is raised to 1·2 by charging, and decreased to 1·172, when as much work as may prudently be taken out of them has been accomplished. The internal resistance, of course, varies with the specific gravity, but averages ·003 of an ohm per cell. After charging, the E.M.F. of the 50 cells is about 107 volts, or 2·14 volts per cell; at the close of a day's work it is 100, or 99 volts, equal to 2, or 1·98 volts per cell.

The motors are of a modified Immisch type, weighing 350 lbs. The Immisch motor has long been noted for its high efficiency and great power, as compared with weight and space occupied, qualities which render it specially serviceable for boat work. The ordinary Immisch motor is also noteworthy for an ingenious arrangement of commutators and collectors, the effect of which is to short-circuit two of the 48 armature coils as they successively reach the point at which they contribute nothing to the result. The effect is to somewhat reduce the resistance in circuit, and to maintain the constancy in direction of the field under the influence of varying loads. But in launch work it has been found better to aim at the greatest possible simplicity, so the motor employed in the Union Canal boats has but one commutator and one collector. In all other respects it resembles the motor which has been placed on the table for your inspection. There are four field magnet coils, having a resistance of ·18 ohm, when hot. They are in series with the armature, which is drum-wound, has 48 coils, and a resistance of ·3 ohm when hot. The commutator has as many segments as there are coils, each coil being coupled to the two segments immediately facing it.

The efficiency of the motor, if run at its most favourable speed, is 85 per cent.; but that speed is too high for the conditions which have to be complied with on the Union Canal, where 4½ miles an hour, equal to 510 revolutions, is the limit prescribed by the proprietors, the North British Railway Company, with the object of avoiding injury to the banks. At 4½ miles the efficiency is only 75 per cent., which becomes 80 per cent. at 6 miles.

The motors are not, consequently, working to advantage on the canal; they would do much better in open water, like a loch or firth, where speed restrictions were not so stringent. The results, all round, would be better in open water, for the resistance to motion in the narrow and shallow canal is very great.

The direction of motion is changed by reversing the current in the motor armature, which can be done almost instantaneously, by means of the switch.

The current from the accumulators passes through a short length, 1¼ inch, of leaden wire, No. 10 B.W.G., which fuses at 42 ampères. Injury to the motor from excess of current is thus automatically prevented.

The greatest effort is required when starting the boat from a position of rest, and it happens, fortunately for electric traction generally, that it is in that position that the motor is capable of exerting its maximum force, for when motionless it is not acting as a generator and producing a current that tends to diminish the energy of the working one sent into it from the accumulators. For the first instant there is nothing but the ordinary conductor resistance of the coils to overcome, and a rush of current could occur which would at least fuse the leaden wire were not the precaution taken to automatically interpose a series of resistances when turning the starting lever. The commencement of the movement admits current to the motor through a resistance of about 2 ohms; this is diminished gradually as the lever passes the second and third contacts, and it is not until it reaches the fourth, by which time the armature is in motion and producing a counter current, that the full current is admitted to the motor. It is impossible, therefore, for an ignorant or careless man to injure his machine. There is no sitting on the safety valve possible in an electric launch.

The controlling switch has three levers. The second sets the speed at 6 or 4½ miles an hour as required, by joining the 50 accumulators all in series, or in two parallels of 25. In the first case the voltage is 107, and in the second 53, when the batteries are fresh, the resulting current being 34 and 24 ampères respectively.

The third lever is the reversing one, and simply changes the direction of the current in the armature.

Neither the second nor third levers can be shifted whilst the current is flowing. By a mechanical arrangement lever No. 1 locks the other two when it is in the "on" position. It must consequently always be moved to "off" before any variation in the current can be effected, so that the armature is protected from any instantaneous changes.

Sparking at, and consequent burning of, the actual contacts is prevented by extra contacts of iron, which take the spark both at make and break.

The propeller shaft is bolted directly to the armature spindle, so that gearing is altogether dispensed with, and loss from friction and annoyance from noise saved, while the space occupied is reduced to a minimum. The shaft passes through an ordinary water-tight gland at the stern, the back and forward end thrust being taken up at the connection with the armature by ball bearings.

Propellers of several patterns have been tried, with the view of finding the most economical form for the special work to be performed on the canal. These experiments have resulted in the selection of a two-bladed propeller, made of phosphor-bronze, having a diameter of 19½ inches and a pitch of 14 inches. This maintains the speed of 4½ miles an hour allowed by the canal authorities, with the least expenditure of current. A three-bladed propeller was tried, but created too much wash.

As the boats are engaged during the day, the accumulators have to be charged by night. This is effected by means of an Immisch shunt-wound dynamo giving, at 750 revolutions, 130 volts and 120 ampères, which is equal to 15,000 watts or 20·9 H.P. For charging, the cells are put in series in each boat, and the four boats in parallel. The average output of the dynamo while charging is, however, only 11,528 watts or 15·4 H.P. Each boat takes, therefore, at the rate of 3·8 H.P. After a full day's work it requires six hours' charging to bring the specific gravity up from 1·172 to 1·2.

The question of efficiency has engaged my attention, but since this paper was undertaken neither time nor opportunity has allowed of special trials being made, and although the company have kindly placed their records at my disposal, I have not been able to extract therefrom the data necessary to enable any trustworthy light to be thrown on this important point. The loads have varied widely; the daily mileage of each boat estimated only, while the accumulators have furnished current for signal bells and lamps. Each boat has to perform a daily and variable proportion of backing and manœuvring at full speed, so that careful special experiments are absolutely necessary to bring out any results of value; and these I hope to obtain the company's permission to make. The makers of the cells claim for them an output of from 75 per cent. to 80 per cent., and Prof. Ayrton has recently shown that, under the most favourable circumstances, even as much as from 85 per cent. to 87 per cent. of the energy put into secondary batteries may be got back again. As improvements in manufacture are continually being made, there is therefore good reason to expect that a brilliant future is before the accumulator branch of electric traction.

INDUCTIVE DISTURBANCES IN TELEPHONE CIRCUITS.*

BY J. J. CARTY.

IT was not known until 1838 that the earth might be used instead of a return wire in the circuit of a telegraph line. This fact was discovered by Steinheil, while making experiments to determine whether the track of a railroad could be used to complete the circuit instead of a return wire. Steinheil's discovery has been considered as one of the most important in the art of telegraphy, and since his time it has been the almost universal practice to use the earth as a return in telegraph circuits. When, however, the earth return is used with the telephone, it is found that owing to the extreme sensitiveness of that instrument, many foreign currents, which would produce but little effect on telegraph instruments, become a source of serious trouble For this reason, in telephony it is often necessary to use a complete metallic circuit. Thus it has come to pass that a return to the original practice of employing metallic circuits as in the case of the crudest telegraph instruments, is now regarded as a most important improvement in connection with that most highly developed of telegraph instruments, the telephone.

To obtain complete freedom from inductive disturbances in the telephone, it is necessary not only to use a metallic circuit, but to place the two wires composing the circuit in a special relation to the source of disturbance. One of the methods of so arranging the wires is shown in fig. 1.

FIG. 1.

In this case the two sides of the circuit, L^2 and L^3, are twisted spirally about each other, so that their average distance from the disturbing wire, L^1, shall be the same. With such a plan, the telephones, *a* and *b*, are not affected by induction from the wire, L^1. This fact has usually been explained by assuming that a current, commencing to flow in L^1, tends to induce two currents in the opposite direction to itself, one in the wire L^2, and the other in the

* Read at the 55th meeting of the American Institute of Electrical Engineers, New York, March 17th, 1891.

wire L³; that both currents are of the same strength because the average distance of L² and L³ from the disturbing wire, L¹, is the same; and that the telephones, *a* and *b*, are silent because they are acted upon by two equal and opposite forces. The above theory seems at first sight to be correct, and indicates the line of explanation adopted in many works treating of the subject.*

I have made a number of experiments which seem to prove that in the case described, the inductive action, instead of tending to produce a simple current in each side of the metallic circuit, actually does produce a number of different currents in each wire and in both directions.

In fig. 2, L² and L³ are two well insulated copper wires, 500 feet

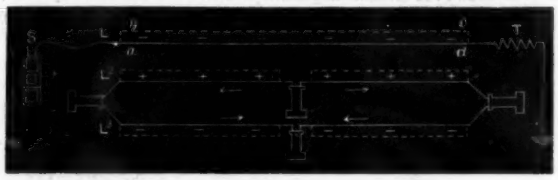


Fig. 2.

long and three feet apart. These wires are joined together at each end through an ordinary telephone. L¹ is a well insulated wire similar to the other two and placed within one-half an inch of L². At one end of L¹ is placed a Blake transmitter, T, and at the other end is placed a subscriber's bell, S; L¹ being grounded at both ends as shown. When the transmitter, T, is operated, either by speaking into it or by vibrating a powerful tuning fork in front of it, disturbances are produced at the end telephones.

If telephones are inserted at the centre of L² and L³ it is found that at those points no sound is heard, while the noise of the end telephones continues as before. This constitutes a simple case of inductive disturbance, and can only be explained by assuming that wire, L¹, acts electrostatically upon the circuit composed of L² and L³, or in other words, that we are dealing with a system of condensers in series, of which L¹ constitutes one plate, the earth another and the wires L² and L³, two intermediate plates which are joined together through the end telephones.

Let us assume that at a given instant, the height of potential along the wire L¹ is represented by the lines *a*, *b* and *c*, *d*, and the charge upon L¹ by the rectangle, *a*, *b*, *c*, *d*. The presence of this charge, which we will say is of the minus sign, is accompanied by an equal but plus charge on L². This produces a minus charge on the wire, L³, which in turn acts upon the earth. Now we will assume that the potential on L¹ is reduced to zero. This causes a restoration of the equilibrium in the circuit composed of L² and L³, which is accompanied by a set of currents as represented by the arrows. The plus charge on L², flowing through the end telephones, neutralises the minus charge on L³, thus leaving a neutral point at the centre of each of the wires L² and L³.

In this and the succeeding experiments the induced charges are represented by rectangles. This is not a strictly accurate method, but as an error in this respect only affects the result quantitatively, and cannot alter the conclusions, I have adopted it on account of the simplicity of treatment which it permits.

The potential along the wire, L¹, at a given instant is represented as being constant, as it is found that owing to the high impedance in the instrument, S, there is practically no fall of potential in the wire itself. Furthermore, it was found in the experiments about to be described that the results were the same whether the disturbing wire was open or connected to earth through the bell, S. There would be a fall of potential along the wire, L¹, if it were of such a length as often found in practice, and the distribution of the charge would be modified accordingly. But as this fact would only affect the location of the neutral points, the question of the fall of potential will not be taken into consideration, and the disturbing wire will be shown open at one end.

Fig. 3 shows the same circuits as used in the previous experiment, except that the wires L² and L³ are caused to change places at their

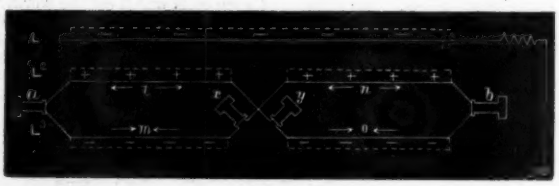


Fig. 3.

centres, but are continued in the same plane, as in fig. 2. This is what is called a "transposition." The telephones at the ends and in the middle are retained as before. Under these conditions, when the transmitter is operated, a diminished sound is heard at *a* and *b*; and *x* and *y*, instead of being silent as in the first case, now emit a sound of the same intensity as *a* and *b*. When telephones are placed at the quarters, *l*, *m*, *n*, *o*, the sounds at *a*, *b* and *x*, *y* continue as before, but nothing is heard at *l*, *m*, *n*, *o*. The effect of this one transposition has been to reduce the disturbance at the end telephones, *a* and *b*, and to cause a shifting of the neutral points from the centres to the quarters, and an increase of their number from two to four.

An examination of the induced charge shows how these results have been brought about. It will be seen by reference to fig. 3, that there is on the first half of L² a positive charge, and on the second half a negative charge, and on the first half of L³ a negative charge, and on the second half a positive charge. When the positive charge on L² discharges, half of it goes through the telephone, *a*, and half through the telephone, *y*. The positive charge on L³ escapes in a similiar manner, half going through telephone *x*, and half through telephone *b*. This produces four currents, two starting from point *l* and two starting from the point *n*. One of the currents from *l* meets a current at *o*, coming from the point, *n*, and one of the currents starting at the point *n* meets a current at *m*, which started from *l*. The currents flowing through the end telephones in this case are not so strong as when no transposition is employed, because they are due to an induced charge which is represented by an area half as great. It is found that as the number of transpositions is increased the number of neutral points is also increased, and that the area representing the charge, which escapes through the end telephones is reduced. To obtain silence, therefore, it is necessary to increase the frequency of transpositions until the discharge through the end telephones is so small as not to produce sounds therein. Fig. 4 shows a circuit containing three

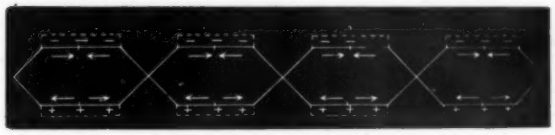


Fig. 4.

transpositions, one at the centre and one half way between the centre and each end. In this case, if we could neglect the resistance of the telephones, the current going through the ends would be reduced to one-fourth of its original proportions, and eight neutral points would be produced, one in each wire at the centre of each transposition.

In practice the impedance of the telephones must be taken into consideration, so that if in fig. 3, the middle telephones *x* and *y* were omitted, the neutral points would be found to move towards the ends, and the currents flowing through the end telephones would be correspondingly reduced.

According to this theory of transpositions, if the instruments and distances between wires on a given circuit remain constant, for a given period of alternations in the disturbing wire, the number of transpositions necessary to obtain silence will depend on the E.M.F. of the disturbing wire, and the specific inductive capacity of the dielectric. An increase in the value of either of these factors will, if silence is to be maintained, require additional transpositions, their number depending upon the value of the change which is made.

Where the disturbing wire is placed at an equal distance from both sides of a metallic circuit, no noise is produced in telephones located in that circuit, and a balance once being obtained, it is independent of both the E.M.F. of the disturbing wire and the specific inductive capacity of the dielectric. Fig. 5 shows such an arrangement of

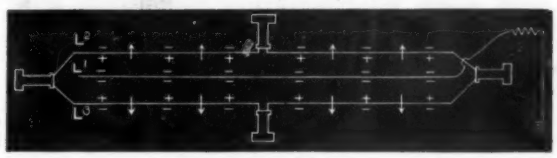


Fig. 5.

circuits—L² and L³ are the two wires composing the metallic circuit placed the same distance apart as before, and the disturbing wire is at an equal distance from both. When the disturbing wire is in operation, no sound is heard at the end telephones, or at telephones located at the centres. This may be accounted for by assuming that at a given instant a negative charge is on the disturbing wire, which produces a positive charge on the inside of L² and L³ and a negative charge on the outside of those wires; and that when the charge is removed from the disturbing wire, a set of currents is set up in the wires L² and L³ in a direction at right angles to their axes, as shown by the arrows. In this case the flow is lateral, and no current passes through the end telephones or through telephones located at the centres. It will thus be seen that this method of arranging wires differs essentially in its action from the plan of using transpositions. Unfortunately, however, its practical application is limited to two circuits.

Where the disturbing wire occupies the position shown in fig. 5, the flow in the conductors is lateral only when the wires L² and L³ are insulated from the earth. If a ground be attached to the centre of L³, as shown in fig. 6, the flow of current becomes longitudinal, and the telephones *a* and *b* are found to be affected by loud disturbances, while the telephone *x*, at the centre of L³, is found to be silent.

This is because the disturbing wire, which we will say is negatively charged, induces a positive charge upon L³ and L² and a negative charge upon the earth. The discharge in this case is effected by two

* "A Handbook of Practical Telegraphy," R. S. Culley, 1858, p. 330. "The Telephone," Preece and Maier, 1889, p. 134. "Die Technik des Fernsprechwesens," Dr. V. Wietlisbach, 1886, p. 135.

currents starting from x, which thus becomes a neutral point, and passing through the end telephones to the ground as shown by the arrows. If the ground be removed from the point y toward the telephone a, the neutral point will be found to move toward telephone b, and if the ground be put at the centre of resistance of [the] telephone a, the neutral point will be found to be at the centre of the telephone

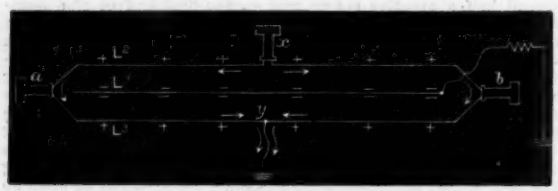


FIG. 6.

b. This is well illustrated in fig. 7, where a and b are telephones of special construction, admitting of the attachment of grounding keys K^1 and K^2 at their respective centres. In this instance, when the disturbing wire is in operation and both keys open, no sound is heard at any of the telephones, the flow of current being lateral. If the key K^1 be closed, sound is immediately heard at telephones x and y located at the centres of L^2 and L^3, but the telephones a and b are still silent. This is because the charge and discharge take place along the conductors L^2 and L^3 to and from the earth at K^1, thus passing through x and y, a being silent because the currents go through it differentially, and b is silent because it is located at a neutral point. To prove that current flows through telephone a, another telephone may be inserted in the ground branch at K^1, and it will be found to be loudly affected. If both keys K^1 and K^2 are closed, silence is again obtained in the four telephones a, b, x, y. In this case the charge and discharge from the wires L^2 and L^3 divide at the centre and flow back and forth at both ends, x and y being

FIG. 7.

silent because they are at neutral points, and a and b are not affected by the currents which flow through them because of the differential action referred to.

Two systems have now been described, one in which the induced current is lateral, and the other in which it is longitudinal. I think it follows from the foregoing experiments, that where wires are twisted about each other, as shown in fig. 1, both of these actions are combined. At the left hand of fig. 8, a cross section of the three

FIG. 8.

wires L^1, L^2 and L^3 [fig. 1] is shown. In this position the wires occupy a place with reference to each other exactly as in fig. 2, and the tendency of the disturbing wire is to cause a longitudinal flow in L^2 and L^3. If repeated cross sections of these wires are made, a point will be reached at which the three wires are disposed, as shown at the right hand of fig. 8, where it is seen that the disturbing wire L^1

FIG. 9.

is at an equal distance from L^2 and L^3, and the tendency is to produce a lateral flow. The actual currents produced must be the resultant of these two actions.

Fig. 9 shows a plan quite different in principle from anything heretofore employed. It is of interest not so much on account of any practical application which it may have at present, but because it is a very striking proof of the electrostatic nature of inductive cross talk between telephone circuits. L^1, L^2 and L^3 are the same wires as used in the previous cases, L^1 being half an inch from L^2, with the addition of an extra wire, L^4, placed half an inch from L^3 and joined by a conductor, w, with the disturbing wire, L^1, L^2 and L^3 are three feet apart. When in this condition the transmitter is operated, no disturbance whatever is heard in the end telephones; if the wire, w, be disconnected, the usual noise is heard, but is found to disappear as often as L^1 and L^4 are joined together. This action is explained by the fact that L^4 is at the same potential as L^1, on account of being joined to it by the wire w, and acts with the same force on L^3 that L^1 does [on L^2. The flow in this case is lateral, as indicated by the arrows; and the telephones are silent.

Neutral points may be produced in a circuit by the use of shunts. Fig. 10 shows the usual arrangement of circuits with the telephones,

FIG. 10.

a and b, at the ends, and another telephone, x, of equal impedance branched between the two wires at the centre. In this case four neutral points are found, two in each wire. The currents produced by the discharge are indicated by the arrows. Thus, by the addition of one shunt, the disturbing currents in the end telephones have been reduced one-half. If similar shunts were placed at the quarters, the currents at the end telephones would be still further reduced to one-quarter of their original strength.

This plan is not a practicable one because of its shunting effect on the telephone current, but is of value as showing one of the actions which occur when instruments are bridged into metallic circuits. It is interesting to note that in fig. 10 the telephone, x, is affected by a current twice as great as that which flows through either of the end telephones.

Before closing I shall describe one more experiment. In fig. 11,

FIG. 11.

L^1 is the disturbing wire and L^2 is a grounded telephone circuit placed one half an inch from L^1. At the centre of L^2 there is an ordinary telephone repeating coil or transformer, C, containing two windings, e and f, of copper wire, each having a resistance of 160 ohms. One end of each winding is grounded, and the other end is connected to the line as shown. Assuming that the impedance of each telephone is equal to that of each coil of the transformer, a neutral point will be found at the centre of each half of L^2, and the disturbing currents flowing through the end telephones will be only half as strong as though the transformer were omitted. If now the connections of the transformer be reversed so that the discharges from the two sections of line pass through it in opposite directions, no magnetism will be produced in the core, k, and consequently the transformer coils offer an easier path to the discharge. This causes the neutral points to move toward the end telephones and consequently reduces the disturbance still further.

I have not had an opportunity of trying this experiment with a transformer whose coils contained a low copper resistance and a high inductance, but, according to theory, we might expect that such a transformer having its coils connected differentially, should free a grounded line of considerable length from cross talk and other electrostatic disturbances. The number of such coils which can be worked in a given line is of course limited, but with properly designed apparatus a large number of them might be used. This arrangement is also interesting when considered with reference to electro-magnetic induction, and brings to mind a question as to whether we may not at some future time abandon the use of metallic circuits and again make use of Steinheil's discovery.

PARLIAMENTARY NOTES.

ON the House going into supply on Monday night, MR. LABOUCHERE, rising, called attention to the item of £1,900 for oil lamps used in the Houses of Parliament. There had recently been a large expenditure with regard to electric light, and there was also a large amount expended in gas. He did not know where these lamps were burnt. It was absolutely impossible that such an amount of oil could be burnt in that House with the gas and electric light they had. He suspected some contractor derived a huge profit out of the transaction, and for that reason he would move the reduction of the vote by the

sum of £1,000, and if the right hon. gentleman's reply was not satisfactory, he should press the reduction to a division. In connection with that subject he thought the right hon. gentleman, the First Commissioner of Works, would confer a public benefit if he would cause a record to be kept of the cost of each electric lamp in the House per hour, because many persons had found that the present forms of electric meters were entirely incorrect.

Mr. Plunket said the parts of the building in which the greatest amount of the expense for lamps was incurred were not those with which hon. members were most conversant. They were the committee-rooms and the official residences, of which there were a great number in connection with both Houses of Parliament. He had carefully investigated that matter in accordance with a promise he had made some time ago, and he had not been able to detect any part of the House in which the number of lamps seemed to be excessive or beyond the requirements of the place, or to discover that the charges for them were exorbitant. The electric light was not installed in those parts of the buildings where the greatest number of oil lamps was used; the committee-rooms were lighted by oil lamps. A larger estimate had been made this year than would otherwise have been the case, from the fact that they had found by experience of autumn sessions that the consumption of gas and oil and electric light was much greater than in an ordinary year. He, for one, greatly preferred the arrangement; but it made the lighting more expensive. For instance, one week's consumption of gas in December was as great as that of three weeks in August. Again, during the recent fogs the number of lamps used in the committee rooms had largely exceeded the average, and this must be taken into account in framing the estimates. The estimates of consumption which they had set out were only approximate, and were made on the assumption that there would be a winter session at the close of the present year; if there was not the money would not be spent. Electric lighting, at all events in the present state of the science, was more expensive than the old system of gas and oil. It now cost about £1,300 a year. They hoped for a saving of £600 in gas, and 145 oil lamps, as against the increase in the cost of electric lighting. He would make inquiries as to what means they had of gauging and checking the cost of the electric lamps.

Mr. Labouchere complained that the right hon. gentleman had not answered the gravamen of his charge, which was, that there was a middleman who received a sum of money each time a lamp was lit, whether for a long or a short time. No private individual would enter into such an arrangement, and he did not see why, with the quantity of officials they had, a certain amount of oil should not be bought and used; they would then save the middleman's profit. They ought to see that such abuses were not carried on under their very noses.

Sir G. Campbell hoped that the right hon. gentleman would look into this question of contracts, as there was certainly great room for economy. He would also call the attention of the right hon. gentleman to the fact that the electric lighting in the reading room was not good.

Mr. H. Wilson pointed out that the charges for lighting remained the same now as they had been when the House used to sit to a much later hour in the morning. He would ask whether it was not the case that some of the lamps belonged to the contractor.

Mr. Plunket said that changes had been made in the recess in the electric lighting of the reading room, by which it was hoped that an improvement would be effected, and more would be done in the next recess. With regard to the question of the contract in connection with oil lamps, it was not a question of the middleman at all; it was a question of economy. There was great irregularity in the number of lamps used, and it was found better to pay a certain sum when a lamp was used. Some of the lamps were burning occasionally for from 12 to 14 hours each night. He did not think that the cost of the lighting arrangements of the House could be materially reduced.

Mr. J. Rowlands remarked that he had been somewhat surprised at the statement of the right hon. gentleman as to the number of hours the lamps were kept burning. He did not think that it was necessary to keep lamps alight for from 12 to 14 hours in the short nights of summer. Was it not possible to extend the system of electric lighting throughout all the offices and rooms of the House? He doubted whether lamps were at that moment (9·30) burning in all the Ministers' rooms. He thought that the present system of lighting the rooms was a very extravagant one. Could not the right hon. gentleman undertake to furnish a return on the subject?

Mr. Plunkett said that he was willing to furnish a return with regard to the prices paid to the contractors.

Mr. Morton inquired whether any hon. member had seen the contractor's bills so as to ascertain how they were made up. He had been trying to find an oil lamp in the building but had not succeeded in doing so. ("Hear," and a laugh.)

Mr. Labouchere said that he did not intend to put the committee to the trouble of dividing upon the question, upon the condition that the return promised by the right hon. gentleman was furnished. It seemed to him that the middlemen who obtained these contracts made a great deal too much. It would appear from the statement of the right hon. gentleman that lamps were kept burning before a Minister's empty chair as though he were a saint. ("Hear," and laughter.)

Mr. Plunket explained that the contract prices were reduced two years ago. It was the unfortunate fate of Ministers to be frequently kept in their rooms from 3 o'clock until half-past 12.

Mr. Conybeare objected to the use of oil lamps on the ground that they were dangerous. He wished to know whether the right hon. gentleman intended to substitute the electric light for them.

Dr. Cameron hoped that an electric light would be adopted that would enable members to read by it. The present electric light was of a most unsatisfactory character.

Mr. Plunket was understood to say that he would inquire into the whole matter, and see what could be done.

THE INFLUENCE OF WATER OF CRYSTALLISATION ON THE CONDUCTIVITY OF SOLUTIONS.

Many substances owe their crystalline character to the water which they hold in a state of chemical combination. For instance, sodium carbonate $Na_2CO_3 + 10\,H_2O$ crystallises in large transparent monoclinic prisms: these upon being heated slightly or allowed to effloresce by being exposed to the air gradually lose their transparency, their crystalline form and crumble to a fine powder. The water of crystallisation has been given up, and the constitution of the salt is now represented by the formula Na_2CO_3. Such compounds with water are chemically known as *hyarates*.

All salts that crystallise do not necessarily contain water, thus common salt, Na Cl, forms fine cubes which are quite anhydrous, although it is possible by taking suitable precautions to obtain a substance of the formula, $Na\,Cl + 2\,H_2O$, and in this case the salt crystallises in forms derived from the triclinic system.

Some of the substances which contain this water of crystallisation part with it very easily, others, again, hold it with great tenacity: sodium carbonate merely has to be exposed to the air, while a salt like copper sulphate $Cu\,SO_4 + 5\,H_2O$ requires to be heated to 200° C. before it gives up its water.

It can scarcely be said to have been satisfactorily determined yet whether these hydrates or hydrated salts exist in solution in combination with their water, or whether they combine with this water only at the moment of crystallisation: and a good deal of research is going on at the present time in this direction.

J. Trötsch, a German scientist, has lately been investigating the electrical aspect of this question of water of crystallisation, and especially its influence upon the conductivity of solutions of metallic salts. In this research the well-known "Kohlrausch telephone" method of examination was employed.

The conductivities of solutions of a large number of different substances were determined for temperatures ranging between 10° and 80° Centigrade, and in order to obviate the difficulty arising from evaporation at the higher temperatures the top of each solution was protected by a thin layer of molten paraffin. At every rise of 10° C. the value of the conductivity was estimated, and the difference between consecutive readings was taken as a mean temperature coefficient for the 10° rise of temperature.

The temperature coefficients of anhydrous salts or rather salts which are anhydrous when solid, such as potassium chloride, sodium chloride, potassium nitrate, &c., rise continually as the temperature rises, or else they attain a maximum value and then remain constant.

On the other hand, the value of the temperature coefficient of solutions of hydrated salts, such as copper sulphate, sodium carbonate, sodium acetate, &c., increases at first, reaches a maximum, and then decreases. This last phenomenon is attributed by Trötsch to the loss by the salt of its water of crystallisation.

Of course there are exceptions to this general rule. Solutions of calcium chloride containing respectively 4·5, 19·2, and 32 per cent. $Ca\,Cl_2$, were found to behave first in the same way as solutions of the anhydrous salts; but in the case of the second solution (containing 19·2 per cent. $Ca\,Cl_2$), the temperature coefficient only undergoes a slight increase in value as the temperature rises, and is far smaller than that of the first and third solutions.

Five solutions of copper chloride were examined in this way; they contained (*a*) 1·35, (*b*) 9·0, (*c*) 18·2, (*d*) 28·7, and (*e*) 35·2 per cent. respectively. Each was found to behave just like a solution of a hydrated salt, and in each case the temperature coefficient reached a maximum value somewhere between 40° and 50° Centigrade. The colour of solutions (*e*) and (*d*) was green, that of (*a*) and (*b*) blue, and the normal colour of solution (*c*) was a bluish-green. At the same temperatures at which the maxima were reached, colour changes took place: the green solutions became yellow and the blue solutions green. In each case these changes seem, therefore, to be conditioned by a dehydration of the salt taking place as the temperature rises.

The above are merely quoted as examples; a great many solutions were examined which it would not serve our purpose

to refer to here. It will be sufficient now, therefore, to observe that Trötsch concludes from these experiments that salts are contained in solution partly as hydrates and partly in the anhydrous state; that at high temperatures the hydrates part with their water especially when in concentrated solution; finally, that the water of hydration, or water of crystallisation, as we have called it, exercises a specific influence upon the electrical conductivity of solutions.

Since no very definite opinion as to the exact nature of this specific influence upon the electrical conductivity is expressed, it is evident that there is room for further research in this direction.

THE PHOSPHORESCENCE OF LITHIA COMPOUNDS IN VACUA AND THE SPECTRA OF COATED TERMINALS.

IN one of our chemical contemporaries there is an interesting paper by E. E. Brooks upon the above subject. Without following the details of the work therein described, we may notice briefly the results.

When examined by Crookes's method in the negative discharge in a vacuum, various lithium salts and minerals exhibited phosphorescent phenomena and continuous spectra.

Lithium sulphate :—A bright lilac blue.

Lithium phosphate :—A bright, light, "Cambridge" blue. When fused with sodium carbonate the colour became bright emerald green, and, unlike the other cases, the glow was prolonged for a second or two after the circuit was broken.

Lithium chloride :—Moderately brilliant, pale, lavender-blue.

Lithium fluoride :—Moderately brilliant, very light flesh colour.

Lithium-silico-fluoride :—Deep blue with darker spots; not so brilliant as the sulphate.

Spodumene :—Golden yellow.

Lepidolite :—Very brilliant deep red with traces of blue.

Petalite :—Very brilliant rich yellow.

Amblygonite :—Trace of white glow.

The nitrate, carbonate, hydroxide also rubellite and indicollite did not phosphoresce; but the nitrate, fused in a glass tube, produced an opaque, enamel-like appearance at the surfaces of contact, by which the inherent yellowish phosphorescence of the German glass became yellower.

By coating with, or simply placing on, aluminium or platinum negative terminals, lithium, thallium, sodium, calcium, or barium salts, and submitting them to a discharge in a vacuum of moderate tenuity, the flame spectra of the various metals were obtained. Other metals gave very faint spectra, or even none with the 1-inch spark coil which was employed; these spectra disappear in high vacua.

THE BIRMINGHAM EXHIBITION.

THE sequel to the Birmingham Electrical Exhibition, which is set forth in the columns of our contemporary, the *Post*, supplies the material for an excellent homily on the insubstantiality of great expectations. It was started with two ostensible objects—(1) To enlighten the benighted residents of Birmingham as to the progress of electrical science, and (2) to put as much money as possible, after the payment of "incidental expenses," into the coffers of three of our excellent local charitable institutions, the Queen's, the General, and the Jaffray Hospitals. For three months the great building was packed with a benevolent throng. In the meantime the governors of the hospitals interested in the distribution of the profits began to found great hopes upon the Electrical Exhibition. They saw the demon of debt disappearing into the dim distance under the fierce glare of the electric light. In the contemplation of this change they were very, very happy until one morning they received a notification to the effect that the share due to the three institutions would not exceed £101 7s. 2d. each.

It is not surprising to hear that the governors of the hospitals concerned in the division of the profits of the Exhibition have betrayed much curiosity to see how this wonderful financial result has been arrived at. Two facts are beyond all possibility of disputation :—(1) The exhibition from a pecuniary point of view was remarkably successful, and (2) it was expressly set forth that after the payment of "incidental expenses" the profits should be devoted to the benefit of the three hospitals.

It was admitted in the subsequent statement of accounts that £7,314 had been taken at the doors, that the payments by exhibitors for space and electric light and power yielded £2,828, and the refreshment contracts £650, that the coal mine brought in £524, the aerial railway £102, the "Shah's Jungle" £60, and the "Egyptian Mystery" £80. But the greatest mystery of all was the £101 7s. 2d. for the hospitals. How had the money been disposed of was the question to which some gentlemen interested in the hospitals desired an answer. The promoters shed a little light—but hardly of electric brilliancy—upon the problem when the noble cheque was despatched to the hospitals. They volunteered the information that some of the principal items of expenditure were to be found under the following heads :—Fitting up of hall and preparing it for the exhibition, £3,856; rent and insurance, £769; bill posting, £1,815; band and entertainments, £1,300; coal and water, £272; law expenses, £255 10s.; medals, £75 10s. These items, with the £304 divided among the hospitals, made up a total of £8,647. This left a balance of £4,412, which is accounted for by salaries, bank charges, royalties, professional charges, travelling expences, and other items of which the details were not given. It is in connection with this unexplained item of £4,412 that the amusing sequel has arisen. It has added quite a new significance to the familiar and frequently comforting phrase "incidental expenses." Under this head the secretary, Mr. T. C. Sharp, received £500, and nine other individuals, who with him were described as the exhibition "syndicate," and sometimes as the "guarantors," were each rewarded with 200 guineas. After the 200 guineas had been voted out of the bank balance, there was only a trifle over £50 left, which, divided among the three charities, would have been too much of a *reductio ad absurdum*. So it was magnanimously resolved that the ten members of the syndicate should refund £25 each out of their honorarium, so as to make up a surplus sufficient to distribute not less than £100 to each institution. Such spontaneous deeds as these shine out like stars in the darkness of a sordid world.

Nevertheless, there will be a tolerably unanimous opinion that the representatives of the hospitals are justified in expressing their amazement at learning "for the first time in their experience that a body of gentlemen, assuming to act in the interests of three charitable institutions of Birmingham, have allocated to their own use very large sums such as those mentioned, leaving a mere residuum for charitable purposes." Before giving the whole circumstances to the public, the chairmen of the respective hospitals afforded the Exhibition Syndicate a chance of showing that they were not in earnest in proposing to put into their own pockets moneys "which have been obtained on the strength of advertisements and promises that they should be devoted to charitable purposes." Only in one case was the appeal of any avail. Mr Ansell needed no pressure to admit that the circular inviting patronage to the Exhibition was open to the construction put upon it by the charities—viz., that the services of the committee, as committee, were to be gratuitously rendered. With that conviction he had no hesitation in forwarding to the hospitals the balance of the 200 guineas. Mr. T. C. Sharp, it will be observed, "expressed surprise" that he should be asked to subscribe more money to the hospital funds, *i.e.*, more than £25 out of £500. From the others a variety of justifications were forthcoming.

There is much instructive reading in the Electric Exhibition's balance sheet beyond the allowances to guarantors or promotors. The expenditure of £1,815 for bill-posting strikes us as a somewhat imposing item, and it would be interesting to see how it compares with the expense incurred in connection with other enterprises. In the public interest, the governors of the hospitals are fully justified in the course they have taken in showing up the Electrical Exhibition in its real aspect. With one exception the people who have made the profit out of the affair practically admit that their first object was to obtain the best result for themselves. Well,

then, why did not they say so from the first? Why set up the farcical pretension that it was for the benefit of the hospitals? There is only one consolatory reflection—it is one of those little jokes that can only be practised once upon a community.—Abstracted from *Birmingham Daily Mail*, April 7th.

NOTES.

The Telephone and the Defence of Portsmouth.—A new and improved telephone service is being established in the Spithead forts, with the view of each fort being placed in direct communication with Cambridge Barracks, the headquarters of the Royal Artillery at Portsmouth. This will necessitate the laying down of new cables.

Storms and Telegrams.—The New England States were visited on Friday last by a severe storm of snow and rain, accompanied by a stiff north-easterly gale. Much damage was done to the shipping in Boston Harbour, and the telegraph and telephone wires have been blown down in all directions. On the Massachusetts Central Railway 373 telegraph poles were blown down within a distance of 20 miles.

The Società Generale d'Elettricità.—This Italian company has just declared a dividend of 10s. per share on last year's operations. The company has in use in Milan 18,162 incandescent lamps, being an increase over 1889 of 3,262. The two stations of Santá Kadegonda, and of G. B. Vico, also supply 852 arc lamps, being 228 more than in the previous year. The net profit in 1890 amounted to £12,740.

Telephony in Barcelona.—A French company was constituted in Barcelona last year, according to Spanish law, for the purpose of acquiring and working the local telephone service. The capital was £80,000, and the number of subscribers is now 1,500. Each new subscriber increases the revenue by from £8 to £12 per annum, necessitating the expenditure of only about 16s.! The Spanish Government has divided Spain into four telephone zones, each of which has the right to extend its connections across the respective frontiers. It is thereby hoped that telephonic communication will shortly be established between Barcelona and Bordeaux, Marseilles, &c.

What Becomes of the "Largest Circulation?"—We clip the following from *Money*:—"Mr. Sanderson, in his recent report on the trade and commerce of Galatz, mentions the following curious fact:—One curious but steadily recurrent article of import is waste paper, of which there arrived a supply of 38 tons during the year. It makes its appearance in the form of bundles of London daily journals, apparently untouched from the time of their issue from their respective printing offices, to aid in swelling the totals of some 'largest circulations.'"

Electric Lighting at Brighton.—At the last meeting of the Brighton Town Council, the Lighting Committee submitted a letter from the Brighton and Hove Electric Light Company, suggesting that the Corporation should treat for the purchase of the company's undertaking. It was stated that the committee thought the company had some claim, recognising that they had been the pioneers, and that they had property. The committee desired to treat with them fairly, properly, and reasonably; but, at the same time, were determined to thoroughly protect the interest of the ratepayers. In support of an amendment, that it was inexpedient at the present time to negociate with the company, it was pointed out that the company's system was altogether different from that to be adopted by the Corporation, and it was urged that it was not right to squander public money by treating with the company. On the other hand, the Council were reminded that the company were fighting for their life against the Corporation, and therefore were deserving of consideration. On a division, 8 voted for the amendment and 16 against. The report was then adopted, 25 voting for it and 7 against.

Charging Station for Electric Launches.—Woodhouse and Rawson United, Limited, have arranged for the erection of a permanent charging station on the banks of the river at Chertsey, under the management of Mr. J. Taylor. The station is now in course of erection, and will be quite ready to undertake the charging of all sizes of electric launches by the beginning of the river season.

The Wave-Lengths of Electrical Oscillations.—In repeating the classical experiments of Hertz upon the wave-lengths of electrical oscillations, H. K. Waitz has arrived at the following conclusions, namely:—(*a*) A discharge of an induction coil of a definite species excites oscillation of different wave-length, which may extend over an interval of many octaves. (*b*) Amongst these electrical oscillations there is one of greater intensity, the wave-length of which is determined by the dimensions of the conductors. (*c*) The electrical oscillations in or upon conductors change their wave-lengths when the medium surrounding the conductor changes.

The French West Indian Cables.—The ss. *Westmeath* left Messrs. Henley's works at North Woolwich on Saturday, April 4th, for Calais. She had on board about 150 knots of heavy cable, and she loads with lighter types at the works of the Société Française des Télégraphes Sousmarins, at Calais. It is intended to complete the whole of this company's system on the forthcoming expedition, and to effect this another steamer has been chartered. She will be fitted with the necessary cable machinery and tanks at Henley's. The work to be done comprises the laying of the Puerto Plata-Martinique section, the completion of the Paramaribo-Cayenne section, and the laying of the Cayenne-Vizeu section.

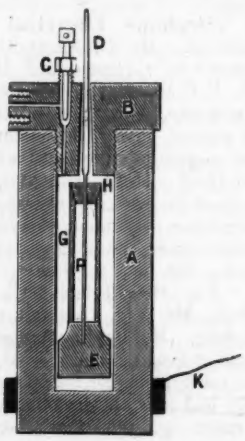
The National Telephone Electrical Society.—On Wednesday, the 25th ult., Mr. C. A. Smith read a paper before the above society on "Magneto and Dynamo-Electric Generators," Mr. A. E. Cotterell, vice-president, in the chair. He dealt with the magneto, showing its relation to the telephone apparatus in general, then with the current generated. He pointed out that magnetic induction was first put to practical use by Clark in 1833. He also treated upon the Siemens armature, and described the working, also the Pacinotti ring armature. The paper was very much enjoyed, and led to an interesting discussion upon the magneto generator. On Friday, the 3rd inst., Mr. W. A. Baxter, chief inspector, read a paper on "The Bell Telephone" before a large assembly of members, Mr. A. E. Cotterell, vice-president of the society, in the chair. He described what led Prof. Bell to find out the means of hearing, and treated upon the working of the receiver, touching upon the points where faults were likely to occur, and how they should be cleared. The paper was very much enjoyed, and there was a large attendance.

The Solubility of Mixtures of Electrolytically Dissociated Substances.—The principles which regulate the influence of two salts upon the solubility in water of each other are those which can be deduced from the general law of mass action as interpreted in the light of the electrolytic dissociation theory; this has been demonstrated by Nernst, and the subject has recently received further attention from A. A. Noyes, another German chemist. Eleven pairs of salts were carefully examined, and the results of the experiments seem to show a very fair agreement with the values deduced from theory. Most of the investigations were carried out with binary electrolytes, but a few ternary electrolytes were shown to yield results equally in harmony with the theory. Experiments were made not only with pairs of salts containing one ion in common, but also with pairs of salts the ions of which were all different. Noyes considers that reckoning back from the solubilities it is possible to calculate the dissociation constants of strong electrolytes. If this is a fact, it is one of considerable importance, for the ordinary method of calculation from the electrical conductivity fails in such cases to give a constant number at all. The details of the experiments and the results, &c., for the 11 pairs of salts examined are given in full in the original paper for which pages 241—267 No. VI. of the *Zeitschrift für Physikalishe Chemie* must be consulted.

Watchman's Clock.—Messrs. Gent & Co., Faraday Works, Leicester, have just received an order for a large ink-marking watchman's clock, with their improved brass key-contact boxes, for the Eastern Counties Asylum for Idiots, Colchester.

The Use of the Gooch Crucible as a Silver Voltameter.—In order to avoid loss of silver by the washing of the deposit in a voltameter, M. Loeb recommends the use of a modification of the well-known Gooch crucible :—A rather tall and narrow platinum crucible having a perforated bottom is fitted into a glass cup terminating in a syphon. The two are united by means of a piece of India-rubber tubing which should be freed from sulphur, although there is no real danger of contact with the silver solution. The apparatus is filled with silver nitrate solution, so that the top of the syphon is not quite reached and is then set upon the stand. The crucible rests in a well-fitting brass block to which the negative wire is attached. The anode consists of a silver cone suspended within the crucible by means of a silver wire attached to a horizontal bar insulated from the cast-iron base. When the electrolysis is complete, the residual nitrate of silver can be entirely removed without in any way disturbing the deposit by simply filling up the crucible with hot water several times. The crucible is then detached from the syphon, dried and weighed.

An Electrical Apparatus for Reactions at High Temperatures and Pressures.—In the current issue of the *Berichte der Deutschen Chemischen Gesellschaft*, W. Hempel describes a new apparatus for reactions at high temperature and pressures. This apparatus we have shown in section in the accompanying figure. The essential features are as follows : A is a steel cylinder containing a porcelain tube, G,



in which the substance under examination is placed. Down the middle of the porcelain tube a thin rod of carbon, P, passes and fits into a carbon block, E. This rod may be heated by passing an electric current through the copper wires D and K. The head of the steel cylinder, B, screws on air-tight and provision is made for pumping in gas through the valve, C, until the desired pressure is obtained. For further details consult the *Berichte*, vol. xxiii., p. 3,388.

Electric Light at Exeter.—At a meeting of the Exeter Town Council last month, the Parliamentary Committee presented a report embodying the terms upon which they were prepared to recommend the Council to withdraw its own application for an order and consent to the company's obtaining one. They had previously proposed that the Council should have the option of purchase at the end of 25, 30 or 35 years ; but the company having written that they would agree to the Council's proposals if the periods when the Council should have the option of purchase were fixed at 28 and 35 years, they now recommended that this proposal be accepted. The Council, however, insists that the first period of optional purchase shall be 25 years, and has informed the company that in the event of their not accepting its terms, it is ready to leave the question of 25 or 28 years to the decision of the Board of Trade.

Electricity and Fire Protection.—The introduction of power into mansions and public buildings for driving electric light machinery affords an opportunity for providing a high-pressure water supply for fire extinguishing purposes. Merryweather and Sons, of London, have devoted considerable attention to this matter, and in some cases the boiler existing is utilised for driving a fixed steam fire engine, arranged to charge a system of hydrants, as at Colonel North's new mansion at Eltham, and, in others, one of the firm's fire pumps is provided, to be driven direct from the piston rod of a horizontal engine, a simple arrangement being fitted for putting the pump in or out of gear at will. This system has been adopted by Mr. Ed. de Segundo for Mr. Hanbury's mansion at Ware, a Merryweathers' patent quick steam raising boiler being also provided, which serves the double purpose of working the steam fire engine in seven minutes after an alarm of fire, should steam not be up in the ordinary boiler, or of driving the electric light machinery in case of accident to the ordinary boiler. Where the machinery is driven by water power at a distance, the current is utilised at the house for driving a fire pump connected to an electric motor, as at Thurland Castle.

Siemens's Dynamos.—The following will doubtless be news to Messrs. Siemens. A certain electrical engineer, in the course of his report on prominent electric lighting stations fitted with Siemens's continuous current dynamos, says : "The shunt circuits of the field magnets of the dynamos obtain their current direct from the armatures. This is being altered so that the field magnet circuit current will be obtained from the mains. This will enable the field magnets of a dynamo to be excited immediately, and the machine started at once, instead of waiting, in some cases, 15 or 20 minutes till the field magnets become excited." The above is possibly a lucid manner of stating that the dynamos were to be converted from short shunt into long shunt machines. We fancy that if a dynamo did not become excited in 20 minutes, the engineer in charge would act like the man who lived next door to an incipient but energetic trombone player, who on being asked what he did while the long drawn out and agonising strains were being perpetrated, replied—"I guess I am learning to swear." Only in the case of the dynamo tender there would, in a 20 minutes' wait, be time to not only learn to swear, but to become a past master in the art of using unparliamentary expressions.

The Channel Telephone and the Press.—London and Paris have now been put into telephonic communication, but the question is whether the proposed tariff will not leave the line unemployed. Eight shillings for three minutes' conversation is a high, and may prove quite a prohibitive, price. On this question, says the *Pall Mall Gazette*, a Belgian journalist writes :—The *Indépendance Belge* employs the Paris-Brussels telephone for 60 minutes every day regularly, and on important occasions for double that duration. Most leading continental journals do the same, so that if the rate of the London-Paris telephone were available by its moderation, it would be a paying concern for the postal authorities at once, whereas at the present price it will remain almost completely unused. Another interesting fact is that whereas Belgium is connected with the London-Paris telephone through the Brussels-Paris line, it is further connected with Germany by a telephonic line running to the frontier at Herbesthal. Germany, as well as France and Belgium, would be a customer of the cable, therefore, were it not for those forbidding prices, which become increased still further in the Belgian or German cases, seeing that if, for instance, a German paper were to take 20 minutes' communication in London for Paris, it would have to take and pay for another 20 minutes to transmit the news from Paris to Brussels, and then a further 20 minutes to transmit it from Brussels to Herbesthal. I believe also that the French authorities are quite ready to make the price as cheap as possible, if not for the general public, at least for the Press, which is the best, because the most regular and permanent customer, of the telephone. The obstacle therefore is one specially created by the English authorities. In illustration of this, I may say that in the case of the Brussels-Paris telephone the authorities first satisfy the requirements of the Press, and only reserve to the communications of private persons such time as is left free by newspaper conversations.

The Electro-Harmonic Society.—We venture to remind our readers of the concert this evening, which is the last of the fifth season, 1890-91.

Electric Lighting in China.—Electric lighting is steadily increasing in China. At the present time there are some 1,700 incandescent lamps being erected in cotton mills near Shanghai.

Electric Lighting at Falcon Cliff, Douglas.—Messrs. Cecil Wray & Co., electrical engineers, Bradford, have secured the contract for the electric lighting of Falcon Cliff Pleasure Grounds and Hotel, Douglas, Isle of Man, for the coming season.

Fire at Judson's.—We are informed by the Atlas Electrical Manufacturing and Supply Company that the fire which occurred at their works on Friday last will not prevent the immediate execution of any orders, as arrangements have been made in order to prevent any unnecessary delay.

Institution of Civil Engineers.—The annual dinner of the Institution took place on Wednesday evening, Sir J. Coode, the President, being in the chair. Speeches were delivered by Mr. Stanhope, M.P., Sir V. Hamilton, Lord Colville of Culross, Mr. Courtney, M.P., the Duke of Teck, and Sir Lyon Playfair.

The Electric Light at Hastings.—The operations of the Electric Light Company are said to be very satisfactory, and meet with approval from all sides. The Hastings Town Council have empowered the company to extend their main from Warrior Square to a point opposite St. Leonards' Pier.

A Telephone to Marseilles.—April 7.—The Paris *Figaro* says that experiments were made yesterday in communicating by telephone between Marseilles and London, the telephone wires between London and Paris and Paris and Marseilles being connected for the purpose. The trial was a perfect success.—*Reuter*.

Telegraphic Communication in Morocco.—According to a *Times* special telegram from Gibraltar, the Spanish Government is to lay a cable this month to connect the port of Ceuta with Tangier, the Moorish political capital, in the interest of Spain. In Gibraltar this is regarded as a very important step, giving the Spaniards a great advantage in case of war.

Electric Light at Weybridge.—The Laing, Wharton and Down Syndicate have registered a separate company with a capital of £15,000 for the lighting of Weybridge, to whom their works and plant there will be shortly transferred. The Board of Trade has submitted a copy of the provisional order that has been applied for to the Chertsey Sanitary authority, who, however, offer no opposition, and propose no amendments thereto.

The Royal Society.—The following papers were down for last night's meeting :—Sir William Thomson, Pres. R.S. —(1) "On Electrostatic Screening by Gratings, Nets, or Perforated Sheets of Conducting Material ;" (2) "On Variational Electric and Magnetic Screening." Prof. Ayrton, F.R.S., and W. E. Sumpner—"The Measurement of the Power given by any Electric Current to any Circuit." Prof. S. P. Thompson—"On Galvano-Hysteresis. Preliminary Notice."

Electric Light Companies and Pavements.—At the last meeting of the Vestry of St. George's, Hanover Square, a complaint was made of the action of the rival electric light companies who have been engaged in laying cables in the parish for some months past. One company, it was said, would take up the paving-stones, and directly they were relaid the other one would lift them again. Several streets and squares had been left in a very bad condition, one of the most disagreeable features being that after the making of the culverts, holes were left for protracted periods, so that the cables might be pulled through. A member asked what the vestry could do, and the chairman replied that it could do the work and charge the companies with the expenses, but no action was resolved upon.

Storage Battery Litigation.—The Foreign Electrical Power Storage Company has commenced a suit against a number of continental firms who, it is alleged, infringe their patents. Those firms, according to the *Elektricitäts Zeitung*, are the Maatschappy, Correns, Gottfried Hagen, and eventually the Oerlikon and Marly-Huber will be included. In all probability the firms named will form themselves into a ring in order to collectively defend their rights against the powerful attacking party, which is mainly backed by the Tudor Company as licensees of the Electrical Power Storage Company.

Poole and White, Limited.—Messrs. Poole and White, Limited, held their first annual general meeting at their offices, 58, Bread Street, Cheapside, on Tuesday last, Mr. Tryon, the chairman of the company, presiding. Mr. Tryon informed the shareholders present of the great success that had attended the company's operations during the past year, and stated that the time had arrived when the company must acquire much larger works than at present, and that for this purpose it was proposed to issue further capital. Though the proceedings were private, we can state on good authority that the shareholders present unanimously adopted the report, and before the close of the meeting it was announced that the greater part of the further capital required was already subscribed.

Electric Lighting at St. Brieuc.—The Thomson-Houston Company of Lynn, Massachusetts, which has hitherto had, in France, only installations for electric lighting by high tension, constant intensity, direct current dynamos, has just completed its first installation with alternating current and transformers, for the lighting of the town of St. Brieuc, making use of the power of a waterfall at Pont Neufs, more than 12 kilometres from the town. This installation, which we shall describe in detail later on, presents interesting peculiarities, for it combines, for the first time, we believe, the coupling in parallel of alternators by means of a choking coil, and the compounding of the alternators, in order to maintain constant difference of potential at the end of the feeders, notwithstanding a fall of potential of 20 per cent., when the alternators furnish the maximum current of 35 ampères each.

Italian Asbestos.—Under this heading, in our last issue, reference was made to the fact that at the Paris Exhibition Messrs. Davey, Paxman & Co.'s battery of nine boilers were covered with the United Asbestos Company's composition. The purport of Messrs. Davey, Paxman & Co.'s testimonial was, however (owing to a printer's error), not correctly stated, the fact being that the firm made the following comprehensive statement as to the thorough way in which the work had been done :—"We have much pleasure in stating that we are *in every way* satisfied with the covering of our boilers and pipes with your asbestos at the Paris Exhibition. —Yours faithfully, Davey, Paxman & Co." The United Asbestos Company attach special value to this certificate, bearing as it does the signature of so high an authority on the best methods of steam economy as Mr. James Paxman.

Prizes.—Amongst the numerous prizes which will be awarded in 1893 by "La Société d'encouragement pour l'industrie nationale" there are two which are of particular interest to electricians, and which it is as well to note. These are as follows :—Prize of 3,000 francs for the production of a material which can be used in the place of guttapercha in one or more of its principal uses, or for work which has contributed to develop the production or improvement of the cultivation of this gum. Prize of 2,000 francs for an apparatus or industrial process which allows of the measurement or evaluation of the insulation of the different parts of an installation when the latter is in full work. The models, memoirs, descriptions, information, specimens, and facts, for the purpose of preserving the rights of the candidates, should be addressed to the Secretary of the Société, 44, rue de Rennes ; they should be sent in before the 1st December of the year preceding the distribution of the prizes ; thus the 1st December, 1891, for the meeting of 1892. This rule is absolute. Programmes, giving full information on the subject, are delivered gratuitously at the house of the Society.

The City Railway.—This railway was opened for Sunday traffic on the 5th inst. 17,000 passengers were carried.

Church Lighting.—It is proposed to light St. Nicholas Cole Abbey by electricity.

The St. Pancras Exhibition.—It is said that 14,000 people visited this exhibition.

Honours for the Cablecrat.—The Exchange Telegraph Company states that the French Government has made Sir John Pender, K.C.M.G., a Grand Officer of the Legion of Honour.

Electric Traction in Guernsey.—The Guernsey Railway Company, which is about to work its 2¾ miles long steam tramway by electricity, as stated in our columns some time ago, has accepted the tender of Messrs. Siemens Bros. for the carrying out of the work.

What's in a Name?—The title of Elmore's Austro-Hungarian Patent Copper Depositing Company, Limited, will in future be Elmore's German and Austro-Hungarian Metal Company, Limited, and the offices of the company have been removed to 64, Cannon Street, E.C.

Photometry.—In view of the considerable interest shown in photometry and photometers by the frequent articles on this subject in current technical journals within the last few weeks, we are asked to mention that Messrs. O. Berend and Co. make a speciality of photometrical supplies, of Hartmann and Braun's Lummer-Brodhem's photometer, Weber's photometer, and down to the simplest types.

Electric Light in Calcutta.—The Howrah Bridge in Calcutta is, says the *Indian Engineer*, to be lighted by electricity. At present the bridge is very badly lighted, and has a movable section 200 feet long on which there are no lights at all. It is now proposed to have thirteen 2,000 C.P. arc lights on the roadway of the bridge and four similar lights for the boat openings under it. Eighteen strong incandescent lights will illuminate the signal stations, watch house and engine house. The aggregate lighting will be equal to 34,384 candles, and to prevent the possibility of failure, the plant will include a spare engine, boiler and dynamo. Messrs. Laing, Wharton and Down are the contractors, and the cost of the plant is to be 42,050 rupees.

Underground Telephone Cables.—At the meeting of the City Commissioners of Sewers held at the Guildhall on Tuesday, Mr. G. Manners presiding, the Streets Committee reported in favour of an application made by the National Telephone Company for permission to place a portion of their telephone cables beneath the public ways. The committee recommended that the permission be coupled with the condition that the company should endeavour to arrange to do the work simultaneously with the electric lighting companies. A letter was received from the secretary to the Brush Electrical Engineering Company, stating that the question of laying telephone cables in the same conduits with electric wires was one which required the gravest consideration, and that, pending further investigation, the company hoped that the commissioners would defer any final decision on the matter. After some discussion, the report was referred back to the committee, with the understanding that the question of subways should be considered on a future occasion.

NEW COMPANIES REGISTERED.

Weybridge Electric Supply Company, Limited.—Capital £15,000, in £5 shares. Objects: To adopt an agreement dated the 20th ult., made between the Laing, Wharton and Down Construction Syndicate, Limited, and P. Mossop for this company, for the sale to the company of an electric lighting installation and the business carried on at Weybridge under the name of "The Electric Lighting Depôt, Weybridge," to carry on at Weybridge and elsewhere the business of an electric supply company in all its branches, and to carry on the business of electricians, mechanical engineers, &c. Signatories (with 1 share each): Major J. A. Travers, Weybridge; G. J. Sealy, M.D., Oak Hill, Weybridge; T. Dix, Weybridge; C. J. Wharton, 82A, New Bond Street, W.; W. F. Ward, Weybridge; G. Mount, Wayside Lodge, Weybridge; L. G. Boor, Rosedale, Weybridge. Registered, without special articles, on the 26th ult., by H. F. Kile, Solicitor, 11, Queen Victoria Street, E.C.

Moss Bay Hematite Iron and Steel Company, Limited.—Capital £308,196, divided into 17,122 6 per cent. preference shares of £8 each and 17,122 ordinary shares of £10 each. Objects: To adopt an agreement mentioned in clause 3 of the articles for the acquisition of the Moss Bay Hematite Iron and Steel Company, Limited, and to carry on the business of ironmasters, miners, mechanical engineers, metal workers, tool makers, electricians, suppliers of electricity, boiler makers, and manufacturing chemists, to buy and sell, manufacture and repair machinery, electrical implements, tools and utensils. Signatories (with 1 share each): W. McCowan, Moresby, Whitehaven; J. S. Randles, 139, Cannon Street, E.C.; D. Mallalieu, Delph, near Oldham; C. J. Valentine, Workington; W. Burnyeat, jun., Millgrove, Whitehaven; W. Hudspeth, Haltwhistle, Northumberland; R. E. Highton, Workington. The number of directors is not to be less than five nor more than seven, the first being the first six subscribers. Qualification, £500. Remuneration to be determined at the general meeting. Registered on the 25th ult. by Speechly, Mumford, Landon and Rodgers, 1, New Inn, Strand, W.C.

Robert Hindle and Company, Limited. — Capital, £15,000 in £50 shares. Objects: To adopt an agreement already prepared to be made between R. Hindle and C. Laycock of the one part, and the company of the other part; to carry on the business of calico printers, bleachers, dyers, vitriol manufacturers, and to acquire, construct, and maintain tramways, railways, manufactories, electric works, stores and conveniences. Signatories (with one share each): R. Hindle, Sabden; Miss E. Hindle, Sabden; C. Laycock, Sabden; T. Anderton, Sabden; R. Kay, Oswestry; Mrs. Watson, 52, Bishop Road, Manchester; Mrs. Kay, Oswestry. The number of directors is not to be less than three nor more than seven, the first being R. Hindle, C. Laycock, and T. Anderton. Qualification: £300. Remuneration to be determined at the next general meeting. Registered on the 6th inst. by Jordan and Sons, 120, Chancery Lane, W.C. Office, Sabden, Lancashire.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

St. James and Pall Mall Electric Light Company, Limited.—A statement of an increase in the nominal capital of this company was filed on the 21st ult. The capital, which was formerly £100,000 divided into 19,980 £5 shares and 100 £1 founders' shares has been increased to £200,000 by the addition of 20,000 shares to be called. Preference shares are entitled to a preference dividend of 7 per cent. per annum. The annual return, made up to the 16th ult., was filed on the 24th ult. 18,680 ordinary and 100 founders' shares are taken up, upon all of which the full amount has been called. The calls paid amount to £93,000, and considered as paid to £500. Office, Mason's Yard, Duke Street, St. James, S.W.

The Taunton Electric Light Company, Limited.—The annual return of this company, made up to the 11th ult., was filed on the 16th ult. The nominal capital is £20,000, in £5 shares. 2,556 shares are taken up, upon 1,769 of which the full amount has been called. The calls paid amount to £8,845, and considered as paid to £3,835. Office, St. James's Street, Taunton.

The Bristol Electricity Supply Company, Limited.

The Weston-Super-Mare Electricity Supply Company, Limited.

The statutory returns of the above two companies, made up to the 7th November last, were filed on the 25th ult. Their nominal capitals are £100, in £1 shares. In each 7 shares are taken up, upon none of which has anything been called. Office, 112, Belvedere Road, S.W.

Windsor and Eton Electric Light Company, Limited. The annual return of this company, made up to the 13th ult., was filed on the 17th ult. The nominal capital is £30,000, divided into 5,950 shares of £5 each, and 250 founders' shares of £1 each. 250 £5 shares are taken up, upon 7 of which the full amount has been called, and upon the remainder £4 per share has been called. The calls paid amount to £968, and unpaid to £39. Office, 54, High Street, Windsor, Berks.

The Canterbury Electricity Supply Company, Limited.

The Cardiff Electricity Supply Company, Limited.

The Hanley (Staff.) Electricity Supply Company, Limited.

The Ipswich Electricity Supply Company, Limited.

The Loughborough Electricity Supply Company, Limited.

The Manchester Electricity Supply Company, Limited.

The Penzance Electricity Supply Company, Limited.

The statutory returns of the above seven companies, made up to the 7th of November last, were filed on the 25th ult. Their nominal capitals are £100 in £1 shares. In each seven shares have been taken up, upon none of which has anything been called. The offices of the whole of the above are situate at 112, Belvedere Road, S.E.

CITY NOTES.

New Shanghai Electric Company, Limited.

The report of the board of directors for presentation at the third ordinary general meeting, states that after paying all expenses, the working account for the 14 months (from 31st October, 1889, to 31st December, 1890), shows a total profit of Tls. 7,705.22, which the directors recommend should be dealt with as follows:—

Plant account, for depreciation	Tls. 3,690.08
Dividend of 7 per cent. to all shareholders for the period ended 31st December, 1890	„ 3,339.00
Carrying forward	„ 676.14
	Tls. 7,705.22

The amount proposed to be written off for depreciation equals about 10 per cent. on the arc plant for the period, and 5 per cent. on the incandescent plant, thus estimating the total value at only Tls. 42,500. This sum is considerably below what the plant could be replaced at, the arc plant having been acquired at a low cost, and the incandescent plant being nearly new. The engineer reports that the machinery and stores are in good order and condition. Reserve power in both departments in case of break down has been added by the company.

It will be observed that the working account for the arc lighting department covers a period of 14 months. There has been a small increase in the number of lamps supplied to the municipality, making a total of 75 now in use. Although at a considerable reduction in the charge per lamp, the revenue from this source represents an increase of Tls. 1,146 for 12 months' working; but, on the other hand, the receipts for private lighting have decreased about Tls. 215 for the same period.

The company have contracted to light the China Merchants' Kinlee-yuen Wharves, with six lamps, for three years from 1st April next, at the same rate per lamp now charged to the municipality.

Owing to the delay caused by strikes, &c., in England, the incandescent lighting plant was not ready until 1st May, 1890, and its actual working, therefore, only covers eight months, and not at full power during that time. With this short period of probation, the directors are not yet prepared to give any definite opinion as to the future prospects of this branch; but they are investigating every feature, and hope to report their conclusions to a future special meeting. The possibility of improvements, in the near future, especially the practicability of working alternators in "parallel," may economise the present cost of plant and working. Any further extension of magnitude will necessarily entail more funds being raised, in some form or other.

The increase in the price of coal during 1890 has further added to the expenditure, as was the case in 1889.

Mr. R. M. Campbell having resigned on leaving Shanghai, Dr. Neil Macleod was invited to join the board. Mr. F. E. Haskell, on his return to Shanghai, was also asked to rejoin. These appointments require confirmation by the shareholders. In accordance with the deed of settlement, Mr. J. Beattie retires from the board, but offers himself for re-election.

The directors have again decided to forego the question of fees, being desirous of putting the company on as sound a basis as possible by the reduction of plant account, before making any charge for their services.

The auditor, Mr. C. J. Dudgeon, resigned on leaving Shanghai, and Mr. R. F. Eastlack was temporarily appointed in his place. The latter now retires, but offers himself for re-election.

Working Account to 31st December, 1890.

Dr.	Tls. c.
To Interest account	98.17
„ Light account	23,209.26
„ Sale of material account	1,318.12
„ Recovered from the Brush Co. for late fulfilment of contract	317.51
	24,943.06

Cr.	Tls. c.
By Charges account	782.12
„ Coal account	5,421.68
„ Fees account, auditor's fee less transfer fee	116.50
„ Fire insurance account	69.54
„ Rent and taxes account	1,496.00
„ Repairs account	547.46
„ Store account	2,845.02
„ Wages account	5,959.52
„ Balance of profit on 14 months' working of arc lighting, and 8 ditto, incandescent	6,069.59
„ Profit on sale of material	1,318.12
„ Recovered from the Brush Company for late fulfilment of contract	317.51
	24,943.06

Profit and Loss Account, 1889.

Dr.	Tls. c.
To Balance at credit	4,050.86
	4,050.86

Cr.	Tls. c.
By Plant account, for depreciation	780.77
„ Preliminary expenses	983.11
„ Dividend to shareholders for year ended 31st October, 1889, at 7 per cent.	2,100.00
„ Balance carried forward	186.98
	4,050.86

Balance Sheet on 31st December, 1890.

Liabilities.	Tls. c.
To capital, 477 shares at Tls. 100	47,700.00
„ Balance of Profit and Loss Account 31st October, 1889, carried forward	186.98
„ Balance Working Account, as above	7,705.22
„ Bills outstanding	468.35
	56,060.55

Assets.	Tls. c.
By balance Agra Bank, less cash due Secretary, 3.25 ...	1,741.78
„ Cash in Hongkong and Shanghai Bank, London ...	383.21
„ Plant Account—cost of arc plant from Shanghai Electric Company, 20,000.00; plus additions and improvements in 1889, 7,780.77; and less depreciation, 780.77	27,000.00
„ Additions and improvements in 1890	3,361.88
„ Cost of incandescent plant	15,828.20
„ Furniture Account	35.00
„ Value of stores in stock	7,068.65
„ Bills in course of collection	641.83
	56,060.55

Elmore's Foreign and Colonial Copper Depositing Company, Limited.

An extraordinary general meeting of the shareholders of the above company was held on Monday last at Cannon Street Hotel to consider resolutions altering the articles of association so as to empower the directors—with the consent of shareholders assembled in general meeting—to pay dividends "either in cash, or by the distribution of specific assets taken at their par value, and in particular of shares, debentures or other securities of any other company, or partly in one way and partly in the other."

The Secretary having read the notice convening the meeting,

The Chairman (Sir John H. Morris) said that before moving the resolutions of which they had received notice, he wished to say that the meeting had been called for the purpose of carrying out the wishes of shareholders as unanimously expressed at the last general meeting of the company held in January. It was then stated to be the unanimous wish of the shareholders that the board should take measures for the distribution of the securities held by the company as if they were cash, and the board were urged to carry this wish into effect. When it was pointed out that this could not be done under existing articles of association, the shareholders present unanimously resolved that the board should have them so altered as to make the distribution of the securities to the various classes of shareholders possible. He dwelt on this point because objection had been taken

to the action of the board. Whatever action had been taken had emanated from the shareholders themselves, and the board's only object was to carry out the wishes of the shareholders. The board had taken counsel's opinion, which was that the distribution of securities could be made if certain specific alterations were made in the articles of association. These alterations were embodied in the resolutions which the secretary had read out, and it only remained for him to put them to the meeting. The chairman then proposed the first resolution, "That Article 109 shall be cancelled." This was seconded.

Sir T. H. FARRAR said that not having been at the former meeting he had had some difficulty in understanding the object of these alterations, and what had occurred to him when he saw the proposal was, that it was in the first instance an extremely questionable thing for a body of shareholders consisting of two different sets with somewhat differing interests, and at this early period in the history of the company to alter what was a fundamental relation between the two sets of shareholders when the company was started. He was himself a holder of both priority and founders' shares in such proportions that it made no difference to him whether an advantage was given to one or the other, and he was consequently able to approach the matter from an impartial standpoint. The distribution, if carried into effect, would alter the relation existing between priority and founders' shares, which alteration he considered to be in itself an evil. As he understood it, the priority shareholders were to at once receive something in the form of shares and debentures which might or might not prove to be more than they would have received if the present state of things had continued. At the present moment it was undoubtedly less, because the shares which were to be distributed among them were at a discount. Moreover, they would not be able to turn these shares into money, since some of them were founders' shares, and could not be sold in the market for a considerable period after the arrangement was made. They would also be giving to the founders something to which they had no right until another £5 in cash had been given to priority shareholders. The company was certain to realise this other five pounds in cash on priority shares, and he would advise priority shareholders not to insist on an immediate distribution, but to wait in the full hope that present difficulties would be got over, and that before long the directors would be able to make another sale of patents, and to distribute in cash the £5 per share to which they were entitled. It was not desirable, in the present state of the company, that these shares should be hawked about the market, and nothing but harm would be done by putting into the hands of shareholders who knew little about business a number of shares, many of which could not be sold at present, and which if sold must be sold at a very great disadvantage. He opposed an immediate distribution, but he saw no reason why in future, after the priority shareholders had received the additional £5 to which they were entitled when the shares were at a premium, and their value in the market well known, why the directors should not distribute shares in lieu of cash. He was therefore prepared to vote for the abolition of Article 109, but if this was carried he should propose an amendment in Article 110 which would preserve to the priority shareholders their right to £5 in cash. Whilst on future occasions there should be power to divide in shares, on this occasion the directors would be bound to give them the cash to which they were entitled.

Prof. LAMBERT said that when he had received the first circular it had seemed to him the most preposterous proposal ever made, but the amendment proposed would meet the desires of the board and do justice as well, and if it was proposed he would be glad to support it to the best of his power. He did not think it would be either legal or equitable for priority shareholders to have the resolution forced upon them by those who would benefit. They were shortly expecting the sale of their American patents, and although the whole of the money thereby realised should belong to the priority shareholders, yet four-fifths would go to the founders if the resolutions were passed as they stood. He was strongly of opinion, in spite of counsel's opinion, that it would be impossible to force any dissentient shareholder to accept shares who said he would have cash. He would not go into the question of whether these shares were really so much more valuable than the Stock Exchange said they were. He himself thought the Elmore process an excellent one, and if the business had been kept a purely manufacturing one, and had not been allowed to get into the promoters' hands, the position of the Elmore Company would have been far higher than it was. If the resolutions were to be passed *en bloc*, he should advise the shareholders to reject them; but if they were asked to give the directors power to distribute the assets as soon as they had been just and carried out their promises, by all means give them the power.

The CHAIRMAN said he would not go out of his way to answer the two gentlemen who had spoken. The board unanimously accepted the amendment; indeed he had himself suggested it to Sir Thomas Farrar that morning. The resolutions if carried would not give the board power to distribute the securities. They could only propose to do so. It would rest with the shareholders whether they should be so distributed or not.

The resolutions were then put. The first, abolishing Clause 109, was carried by about 30 votes to 2. The second was carried unanimously. Upon the third being proposed,

Sir THOMAS FARRAR moved his amendment, Mr. LAMBERT seconded, and the resolution as amended was carried unanimously also.

Mr. F. L. RAWSON made a few observations, and stated that his own idea was that it was the duty of the directors to make the distribution both to the holders of priority and founders' shares as rapidly as possible, as the company was not formed to hold assets, but to distribute them. No doubt the reason why the shareholders were so anxious at the last meeting that the distribution should be made was that at that time the shares were standing at a different price to what they were now. He called attention to the fact that the proposed alteration in Clause 110, when legally interpreted, would not carry out the intention of the shareholders, but that it was impossible to give an opinion off-hand. It was clear what the wishes of the shareholders were, and therefore it might be necessary to call further meetings to alter the articles so as to carry out the intention of the meeting. One of the chief objections of the shareholders to distribution generally was the fear of still further lowering the price of the shares. A way of getting out of this difficulty would be by the formation of a trust company (now being a good time whilst the shares were low), the precedents being the Globe Trust Company, originally formed to deal in a similar manner with telegraph companies' shares, and the Nobel Dynamite Trust Company. The shares possessed by this company, instead of them being thrown upon the market, would be held by the trust company, and the certificates issued, whilst any shares taken by the company would give cash to be distributed to the priority shareholders, and holders of shares in the different Elmore Companies would have the opportunity of exchanging for trust company's shares, thus averaging the dividends paid by the various companies, an opportunity which would be largely availed of. One of the largest shareholders in the company, and one of the best financial authorities, had stated that he was prepared to exchange. In addition, outside investors would have the benefit of investment in the trust company, whilst at present they did not know in which company to invest.

The priority shareholders having withdrawn to one side of the room, a meeting of founders was held, at which the three resolutions as amended were passed.

Another meeting of all the shareholders was then held, at which the business done at the two former ones was confirmed, and a vote of thanks to the chairman and directors concluded the business of the day.

Foreign Electric Date and Time Stamp Company.

THE statutory meeting of the Foreign Electric Date and Time Stamp Company, Limited, was held on Tuesday at the offices, 90 and 91, Queen Street, E.C. Mr. A. Torkington, chairman of the company, presided.

The CHAIRMAN stated that the board had received notice from their solicitor that the transfer of the French and Italian patents had been duly concluded and registered, both in Paris and Rome. He regretted to report that Mr. Grumwade had retired from the board of directors. He next read a report which the board had received from their general manager to the effect that great progress had been made in the preliminary formation of the company's business in France. Further improvements had been made in the stamp, and it was now adaptable to other purposes beyond what it was originally intended for, and illustrating the extreme usefulness of the patent. After some further allusions to the patents the report stated that the prospects of the company, from a financial standpoint, were of the most satisfactory character.

The proceedings then terminated with a vote of thanks to the chairman.

The Oriental Telephone Company, Limited.

THE directors submit to the shareholders the following report and balance sheet for the year ending 31st December, 1890:—

The revenue account shows a balance to credit of £8,835 8s. 11d., which, together with £1,237 2s. 8d. brought forward from 1889, shows an amount of £10,072 11s. 7d. available for disposal, which the directors recommend should be dealt with as follows:—To add £2,500 to the reserve fund; to write off £832 19s. 7d., in reduction of capital expenditure, and to pay a dividend of 2½ per cent. free of income tax on the total paid up capital of the company, which will absorb £4,488 12s. 3d., leaving £2,250 19s. 9d. to be carried forward.

The shareholders will notice that an alteration has been made in the mode of appropriating the profits. They will have gathered from former reports that the directors have been endeavouring to come to some arrangement with the holders of vendors' shares for a re-adjustment of capital account. A conference was held last autumn with one of the largest holders, and at his suggestion the services of an actuary were called in, in order that a disinterested opinion might be obtained of the relative values of the two classes of shares. The actuary having raised a question as to the correct interpretation of the agreements with the vendors relating to the payment of dividends, the point was submitted to counsel, and in pursuance of the advice received, it has been deemed necessary to declare the dividend rateably on the paid up capital of the company, vendors' shares included, and to carry the dividends declared upon the vendors' shares to a separate account, from which it will be distributed to the holders of the ordinary shares until their claims, according to the agreements with the vendors, have been discharged.

By this arrangement the deficiency to which those agreements relate has to be made up exclusively out of the dividends upon the vendors' shares, without any obligation on the part of the holders of ordinary shares to bring the dividends on those shares into account for the purpose of making up such deficiency.

The distribution now recommended on the total paid up capital of the company is equal to £3 12s. 2d. per cent. on each ordinary share issued prior to February 4th, 1886, as compared with £3 per cent. last year.

The Indian companies during the past year show an improvement, the Bengal Telephone Company having paid 5 per cent. against 4½ per cent. the previous year, and the Bombay Company 4 per cent, as against 3 per cent. The increase would have been larger but for the action of the Indian Government, to which the directors have called attention in previous reports. The Telephone Company of Egypt

has declared a dividend of 6 per cent. for the past year on its preferred shares, carrying forward £1,508 5s. 5d.

All the foregoing dividends on the shares held by this company have been brought as usual into the accounts appended. The branches worked directly by the company nearly all exhibit an improvement on previous returns, which is partly due to the rise in silver.

In order to provide the Telephone Company of Egypt with further working capital for extensions in that country, your directors have taken up £1,500 of its 6 per cent. debentures. The accounts of the China and Japan Telephone Company have not yet been closed, but they point to a small surplus after paying debenture interest.

By a recent Act of Parliament, companies are enabled, at a moderate expense, to amend their memoranda of association. The directors, whilst they will always bear primarily in mind the original objects of this company, have come to the conclusion that it is desirable that the powers of its memorandum of association should be extended so as to authorise the supply of electric apparatus and material, and the application of electric power generally.

The resolution mentioned in the notice on the back of this report will therefore be submitted for the consideration of the meeting.

The retiring directors at the present meeting are the Right Hon. G. A. F. Cavendish Bentinck, M.P., and Mr. B. St. John Ackers, both of whom being eligible, offer themselves for re-election. The auditors of the company, Messrs. Deloitte, Dever, Griffiths & Co., also retire, and offer themselves for re-election.

REVENUE ACCOUNT for the year ending 31st December, 1890.

Dr.	£	s.	d.
To expenses in London—(Directors' fees, £1,000; salaries, £761 14s.; rent, £100; office expenses, &c., including telephone subscription, £83 13s.; stationery, printing, &c., £44 19s. 6d.; legal expenses, £48 1s. 4d.; postages and telegrams, £24 12s. 5d.; depreciation on office furniture, £12; audit fee, £52 10s.; income tax, £34 18s.)	2,162	8	3
„ Indian agency expenses	225	2	1
„ balance transferred to profit and loss account ...	8,835	8	11
	£11,222	19	3

Cr.	£	s.	d.
By net profit on working of the company's exchanges to this date, including dividends and interest on shares and debentures held in subsidiary companies	10,864	12	6
„ sundry commissions and interest	347	1	9
„ transfer fees	11	5	0
	£11,222	19	3

PROFIT AND LOSS ACCOUNT, 31st December, 1890.

Dr.	£	s.	d.
To amount transferred to reserve fund	2,500	0	0
„ amount transferred in reduction of capital expenditure	832	19	7
„ balance carried down	6,739	12	0
	£10,072	11	7

Cr.	£	s.	d.
By balance of profit and loss, 1889 ... £4,964 7 10			
Less dividend 29th April, 1890 ... 3,727 5 2			
	1,237	2	8
„ balance transferred from revenue account, 1890 ...	8,835	8	11
	£10,072	11	7
By balance	£6,739	12	0

BALANCE SHEET, December 31st, 1890.

Dr.	£	s.	d.
To capital authorised—300,000 shares of £1 each	300,000	0	0
„ Capital issued—(220,000 shares of £1 each, 11s. called, £121,000; 3,494 shares of £1 each, issued as fully paid, £3,494; 75,000 shares of £1 each, issued to vendors as fully paid, £75,000) ...	199,494	0	0
Less calls unpaid	2	19	5
	£199,491	0	7
„ Sundry creditors	347	13	6
„ Unclaimed dividends	75	2	1
„ Exchange revenue, 1891—Subscriptions received for periods beyond 31st December, 1890	1,648	16	7
„ Reserve fund—			
As per last account	4,500	0	0
Transferred from profit and loss, 1890 ...	2,500	0	0
„ Profit and loss—			
Balance	6,739	12	0
	£215,302	4	9

Cr.	£	s.	d.
By Telephone patents, goodwill, &c., £71,000; expenditure on exchanges to date, £34,832 19s. 7d.; less written off to profit and loss, 1890, £832 19s. 7d.	105,000	0	0
„ Shares, &c., held in subsidiary companies—			
11,825 Preferred shares in Telephone Company of Egypt, Limited, of £5 each;			
3,875 deferred shares in Telephone Company of Egypt, Limited, of £5 each;			
14,136 shares in China and Japan Telephone Company, Limited, of £1 each;			
14,810 shares in Bombay Telephone Company, Limited, of Rs. 25 each;			
5,516 shares in Bengal Telephone Company, Limited, of Rs. 100 each;	91,937	7	11
50 7 per cent. mortgage debentures of China and Japan Telephone Company, Limited, of £100 each;			
15 6 per cent. mortgage debentures of Telephone Company of Egypt, Limited, of £100 each;			
Indian Government paper, Rs. £1,000			
„ Stores on hand—At branches, £1,993 15s. 8d.; less reserved for depreciation, £500	1,493	15	8
„ Office furniture, £162; less written off to profit and loss, 1890, £12	150	0	0
„ Reserve invested—Deposited with bankers ...	4,500	0	0
„ Sundry debtors	7,640	18	9
„ Cash at Alliance Bank, fixed deposit, £3,000; on current account, £753 10s. 11d.; and in hand and with agents abroad, £826 11s. 6d. ...	4,580	2	5
	£215,302	4	9

New Australian Electric Company.—This company held its annual meeting in Melbourne on the 23rd of last month. The report submitted to the meeting stated that during the past 12 months 1,000 extra lamps had been supplied, 1,400 extra lamps had been installed and were awaiting electric current from the stations, and 900 lamps had been supplied for isolated plants. The Richmond station was being enlarged by the addition of four more engines, dynamos and boilers, which would bring its capacity up to 28,000 lamps. The chairman stated that during the past twelve months their nett profit had amounted to £3,615 16s. 5d., and that the total balance of £4,716 4s. 8d. meant a 20 per cent. profit on their paid up capital. No dividend would, however, be declared, the principal reason being that the company intended to make very large extensions in its stations and mains.

The Eastern Extension Australasia and China Telegraph Company, Limited.—It is stated that the accounts to December 31st show a profit balance of £106,257 after payment of three interim dividends. The directors propose to distribute, on April 22nd, the usual dividend of 2s. 6d. per share, making a total dividend of 5 per cent. for the year 1890, besides a bonus of 4s. per share, or 2 per cent., making a total distribution of 7 per cent. for the past year, £25,007 having been carried to the reserve fund, which now stands at £495,239.

Erie Telegraph Company.—The directors have under consideration a proposition from a party representing a Texas syndicate to sell a portion or all of their 70 per cent. interest in the stock of the South Western Telegraph and Telephone Company for $700,000, which is equivalent to $50 per share for the Erie stock.

St. James and Pall Mall Electric Light Company.—The allotment letters for the 10,000 £5 preference shares recently offered by the St. James and Pall Mall Electric Light Company, Limited, have been posted.

TRAFFIC RECEIPTS.

The Brazilian Submarine Telegraph Company, Limited. The receipts for the week ending April 2nd, 1891, amounted to £5,136.

The City and South London Railway Company. The traffic receipts for the past week amounted to £901.

The Cuba Submarine Telegraph Company, Limited. The estimated traffic receipts of the Cuba Submarine Telegraph Company, Limited, for the month of March, were £4,000, as compared with £4,018 in the corresponding month of last year.

Direct Spanish Telegraph Company, Limited. The estimated traffic receipts for the month of March, 1891, are £1,930, as against £2,382 in the corresponding period of last year.

The Eastern Telegraph Company, Limited. The traffic receipts for the month of March were £58,447, as against £58,471 for the same period of 1890, or a decrease of £24.

The Great Northern Telegraph Company. Receipts in March, 1891, £22,800; 1st January to 31st March, 1891, £64,400; corresponding months 1890, £60,200; corresponding months 1889, £63,000.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending April 3rd, 1891, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Company, were £4,165.

The West India and Panama Telegraph Company. The receipts for the ha month ended March 31st, 1891, are £3,338, as compared with £3,860 in corresponding period of 1890.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Amount Issued.	Name.	Stock or Share.	Closing Quotation. (April 2).	Closing Quotation. (April 9.)	Business done during week ending April 9, 1891. Highest.	Lowest
250,000*l*	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	99 —102	99 —102	...	...
1,381,380*l*	Anglo-American Telegraph, Limited	Stock	47 — 48	46½— 47½	47⅜	47⅛
2,809,310*l*	Do. do. 6 p. c. Preferred	Stock	84½— 85½	84½— 85½	85½	84⅜
2,809,310*l*	Do. do. Deferred	Stock	11 — 11½	11 — 11½	...	...
130,000	Brazilian Submarine Telegraph, Limited	10	11⅜— 12 xd	11½— 12	12	11⅜
84,500*l*	Do. do. 5 p. c. Bonds	100	100 —103	100 —103	101	...
75,000*l*	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	103 —107	103 —107	...	...
63,416	Brush Electric Engineering Ordinary, Nos. 1 to 63,416	3	2⅜— 2⅝	2⅜— 2⅝	2½	2 5/16
63,416	Do. do. Non cum. Preference, Nos. 1 to 63,416	2	1⅝— 2	1⅝— 1⅞	1 11/16	1 11/16
50,000	City and South London Railway, Nos. 1 to 50,000	10	5½— 6½	5½— 6½	6	5 1/16
$7,216,000	Commercial Cable, Capital Stock	$100	107 —109 xd	107 —109	109	...
224,850	Consolidated Telephone Construction and Maintenance, Limited ...	14/-	7/16— 9/16	7/16— 9/16	...	...
20,000	Crompton & Co., Ltd, 7 p. c. Preference Shares, Nos. 1 to 20,000	Stock	5 — 5⅛	5 — 5⅛	...	...
16,000	Cuba Telegraph, Limited	10	10½— 11½	10½— 11½	10⅝	...
6,000	Do. do. 10 p. c. Preference	10	16½— 17½	16½— 17½	17	16⅝
12,931	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	3⅜— 4¼ xd	3⅜— 4¼	3⅝	...
6,000	Do. do. 10 p. c. Preference	5	9 — 10 xd	9 — 10	...	...
60,710	Direct United States Cable, Limited, 1877	20	10½— 10⅝	10½— 10⅝	10⅝	...
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	14⅛— 14⅜	14⅛— 14⅜	14⅜	14⅛
70,000	Do. 6 p. c. Preference	10	15½— 15⅝	15½— 15⅝	15⅝	15 7/16
200,000*l*	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	107 —110	107 —110	109	...
1,200,000*l*	Do. 4 p. c. Mortgage Debenture Stock	Stock	107 —110	108 —111	110	106¼
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	14⅜— 15¼	14⅜— 15	15⅛	14 13/16
91,800*l*	Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	103 —106	103 —106	...	...
325,200*l*	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	104 —107	104 —107	105⅛	105
320,000*l*	Do. 4 p. c. Debenture Stock	Stock	105 —108	105 —108	106½	106
145,300*l*	Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343	100	103 —106	103 —106	...	...
198,200*l*	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	103 —106	103 —106	...	...
201,600*l*	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	99 —101	99 —101	100⅛	99¼
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	5½— 6½	5½— 6½	...	...
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	4½— 5	4½— 5	...	...
66,750	Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750	2	1 — 1⅛	1⅛— 1⅛	1 1/16	1⅛
70,000	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	3 — 3⅛	2⅞— 3⅛	3 1/16	2⅞
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd.	2	1 — 1⅛	1 — 1⅛	1⅛	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 only paid)	5	2½— 3½	2½— 3½	...	...
180,227	Globe Telegraph and Trust, Limited	10	9⅛— 9⅜	9⅛— 9⅛	9 7/16	9⅜
180,042	Do. do. 6 p. c. Preference	10	15 — 15½	14⅞— 15½	15½	14⅞
150,000	Great Northern Tel. Company of Copenhagen	10	17¼— 17⅜	17¼— 17⅜	17⅜	17⅜
220,000*l*	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	103 —106	103 —106	105½	104½
9,384*l*	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ...	10	10½— 11½	10½— 11½	...	...
5,334*l*	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	11 — 12	11 — 12	...	...
41,600	India-Rubber, Gutta Percha and Telegraph Works, Limited ...	10	18½— 19½	18½— 19½	19½	19
200,000*l*	Do. do. 4½ p. c., Deb., 1896	100	102 —104 xd	102 —104 xd	...	...
17,000	Indo-European Telegraph, Limited	25	39 — 41	40 — 42	41	40¾
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000	10	7⅛— 8⅛	7⅛— 8⅛	...	...
11,334	Do. do. Preference Nos. 5,667 to 17,000 ...	10	9⅛— 9⅜	9⅛— 9⅜	...	...
38,348	London Platino-Brazilian Telegraph, Limited	10	6½— 7½	6½— 7½	...	...
100,000*l*	Do. do. do. 6 p. c. Debentures	100	105—108	105 —108	...	...
43,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£9 paid)	10	8⅜— 9⅛	8⅜— 9⅛	9⅛	...
438,984	National Telephone, Limited, Nos. 1. to 438,984	5	4⅜— 4⅝	4⅜— 4⅝	4⅝	4⅛
15,000	Do. 6 p. c. Cum., 1st Preference	10	13 — 13½	13 — 13½	13 7/16	13⅜
15,000	Do. 6. p. c. Cum. 2nd Preference (£8 only paid)	10	10 — 10½	10 — 10½	10	...
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	5/16— 7/16	5/16— 7/16	...	...
9,000	Reuter's Limited	8	9 — 9½	9 — 9½	9⅜	9¼
209,750	South of England Telephone, Limited, Ordinary Nos. 1 to 2,000, 2,501 to 3,500, 93,251 to 300,000	1	⅛— ¼	⅛— ¼	...	...
20,000	Do. 6 p. c. Cum. Pref., Nos. 1 to 20,000 (£3½ only paid)	5	3 — 3½	3 — 3½	...	...
3,381	Submarine Cables Trust	Cert.	115 —120	115 —120	...	...
78,949	Swan United Electric Light, Limited ... ... (£3½ only paid)	5	4½— 5	4½— 5	4⅝	4 1/16
37,350	Telegraph Construction and Maintenance, Limited	12	45 — 47	45 — 47	46½	45½
150,000*l*	Do. do. do. 5 p. c. Bonds, red. 1894	100	102 —105	102 —105	...	...
58,000	United River Plate Telephone, Limited	5	2½— 3½	2½— 3½	...	...
146,128*l*	Do. do. 5 p. c. Debenture Stock ...	Stock	85 — 95	85 — 95	...	...
3,200*l*	Do. do. 7 p. c. Debs., Nos. 1 to 1,000 ...	100	... ...	... ...	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	8 — 9	8 — 9	...	...
290,900*l*	Do. do. do. 5 p. c. Debentures	100	97 —100	98 —101	...	...
30,000	West Coast of America Telegraph, Limited	10	2½— 3½	3 — 3½	...	...
150,000*l*	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	92 — 97	92 — 97	94½	...
64,174	Western and Brazilian Telegraph, Limited	15	12 — 12½	12 — 12½	12¼	12⅛
27,873	Do. do. do. 5 p. c. Cum. Preferred	7½	6⅞— 7¼	6⅞— 7¼	...	...
27,873	Do. do. do. 5 p. c. Deferred	7½	5¼— 5⅝	5¼— 5⅝	5⅝	5 9/16
200,000*l*	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	103 —106	103 —106	104½	...
250,000*l*	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	103 —106	103 —106	105	...
88,321	West India and Panama Telegraph, Limited	10	2⅞— 3⅛	2⅞— 3	2⅞	2 13/16
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	11½— 12	11½— 12	11⅝	...
4,669	Do. do. do. 6 p. c. 2nd Preference ...	10	11½— 12½	11½— 12½	...	...
$1,336,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	120 —125	120 —125	...	...
175,100*l*	Do. do. 6 p. c. Sterling Bonds	100	100—104	100 —104	...	..
42,853	*Westminster Electric Supply Corporation, Ord., Nos. 101 to 42,953	3	3⅞— 4⅛	3⅞— 4⅛	...	...

* Subject to Founders' Shares.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Blackpool Electric Tramway Company, Limited, £10 (£6½ paid), 7½—7⅞.—City of London Electric Lighting (Pioneer), Shares of £50, £25 paid, 27—30.—Elmore's Austrian Copper Depositing, 20s., 10s. Dis.—Elmore's Priorities, 3¾—4¼.—House to House Company (£5 paid), 4¾—5¼.—London Electric Supply Corporation, Ordinary (£5 paid), 2⅜—2⅝.—Manchester Edison and Swan Company, £9 (£1 paid) 2s 6d.—5s.—St. James's and Pall Mall Electric Light £5, 5⅛—6⅛.—Woodhouse & Rawson Ordinary of £5 (£2 10s paid), 2⅛—2⅜.—Preference, fully paid 3⅞—4⅛.—Debentures 90—95.—Woods Electric Car, £10 paid, ¾—1.

BANK RATE OF DISCOUNT.—3 per cent. (29th January, 1891).

THE PROPAGATION OF THE HERTZ ELECTRIC UNDULATION IN AIR.

By MM. EDOUARD SARASIN and LUCIEN DE LA RIVE.

We had the honour of presenting to the Academy the first results which we obtained on repeating M. Hertz's splendid experiments on rapid electric oscillations.* We confined ourselves then to the case in which the electric undulation is transmitted along a conducting wire; since then we have repeated another of M. Hertz's experiments, which consisted in following the propagation of the electric induction through the air in the absence of any metallic conductor. The primary exciter is placed in front of a large plane metal screen and parallel to it. The electric undulations proceeding from it are propagated through the air and reach the metal screen, which serves as a mirror for them, the reflected waves then forming with the direct waves, a system of stationary waves, the first node of which is at the mirror.

In order to study the system of sound waves established in front of the mirror, the circular resonator is placed in two different positions; (1) it is kept constantly parallel to the mirror and to the primary, *i.e.*, in the plane of the wave; (2) it is displaced in the plane followed normally on the mirror by the axis of the primary, the plane of vibration. In both cases the results agree absolutely as regards the position of the equi-distant maxima and minima of electromotive force. Besides these two methods, M. Hertz has employed a third, which consists in causing them to be crossed on the same resonator by the waves reaching it from a single exciter, either directly through the air, or along a conducting wire.

We sum up in the following table the results which we obtained with 10 different circles.*

In this table, we give the mean of the measurements obtained with each circle, and for the sake of brevity we have not separated those obtained with primary exciters of different dimensions, these measurements not showing any systematic difference. In these last experiments in the air, as in our former trials along the wires, we found, in fact, that *a circular resonator always gives the same length of wave*, even when the dimensions of the primary vary within certain limits.† Thus, then, here again we observe what we have termed *multiple resonance*.

In the case of great lengths of wave circles of 1 metre and ·75 of a metre, which are very soon carried far beyond the mirror, being almost comparable to the direct action of the primary, only one ventral segment and one node is to be observed with any degree of precision besides the node which occurs on the mirror itself. With smaller circles, to which the dimensions of the mirror are better suited, we can easily distinguish three ventral segments and three nodes, including that of the mirror. The equidistance of the ventral segments and nodes is, we find, fairly satisfactory.‡

The most important of our work is shown by the comparison of the figures in the last three lines of our table, which show that the wave-length obtained for each circle in the case of propagation through air, is to all intents equal to that which the same circle gives along the wires, the quarter of both being very nearly equal to double the diameter of the corresponding circle. Whence it follows that *the speed of the propagation of the Hertz electric undulations through air is to all intents the same as that with which they are transmitted along a conducting wire.*§

Diameter of the circle D.	1 m. thick wire 1 cm. d.	·75 m. thick wire.	·50 m. thick wire.	·35 m. thick wire.	·35 m. fine wire 2 mm. d.	·25 m. thick wire.	·25 m. fine wire.	·20 m. thick wire.	·20 m. fine wire.	·10 m. thick wire.
1st ventral segment ...	2·11	1·60	1·11	·76	·75	·46	·54	·39	·42	·21
1st node	4·14	3·01	,,	1·69	1·51	·94	1·17	·80	·93	·41
2nd ventral segment ...	,,	,,	,,	2·30	2·37	1·63	1·89	1·26	1·55	·59
2nd node	,,	,,	,,	3·04	3·10	2·15	2·40	1·69	2·05	·79
3rd ventral segment ...	,,	,,	,,	,,	,,	2·71	2·94	,,	2·46	·96
3rd node	,,	,,	,,	,,	,,	3·14?	,,	,,	,,	,,
½ λ air	2·03	1·41	1·11	·76	·8	,,	·60	·43	·51	·19
½ λ wire	1·92	1·48	·98	·73	,,	,,	·56	,,	·45	,,
2 D	2·00	1·50	1·00	·70	·7	,,	·50	·40	·40	·20

From these experiments he concludes, from the great wave lengths of the mirror, that the rate of propagation through the air, in the absence of any conducting wire, is nearly double that observed along a wire, and that these two speeds are in the ratio of 7 : 4, which does not bear out Maxwell's theory, he having maintained that these two speeds were equal.

Having regard to its importance from a theoretical point of view, we gave special attention to the verification of this point. Having proved, by our former experiments along the wires, the constancy of the undulating period of a given circular resonator, whatever may be the primary exciter by the action of which it is brought into play, the same exciter, on the contrary, showing as many wave lengths as we employ circles of different magnitudes, we applied ourselves to the comparison of the length of wave given by a circular resonator along wires with that which it gives in the air in the absence of wires.

As a reflecting surface, we employed a large sheet of lead, 2·8 metres high, and 3 metres wide, kept plane and vertical by its own weight. The primary exciters and the large Rhumkorff induction coil were the same as we used in our preceding experiments. The exciter was placed in front of the mirror, its axis being horizontal, and its interruption at the normal point in the centre of the metallic screen. Its distance from the latter varied from 4 metres to 10 metres. The circular resonator was fixed on a carriage sliding along a large wooden bench already described.

We have varied the conditions of the experiment considerably, and repeated the observations several times.

* *Comptes Rendus*, January 13th, 1890.

MAGNETIC MINERALS IN METEORIC IRON.

The meteoric iron obtained from various districts in Hungary, but especially from Magura and Arva, has recently been placed under examination by Weinschenk, Berthelot, Friedel, and others.

Amongst the constituents several highly magnetic minerals have been discovered. The principal mass of these meteorites, which are found in Hungary, consists of heavy irregularly-

* The sensibility of the micro-metric screw is a very important item in researches of this kind, especially with small circles which only give very feeble sparks. In the last case we used a screw giving the 400th part of a millimetre.

† The intensity of the spark of the resonator being much more feeble in this experiment than in that with the wires, and, moreover, diminishing much more rapidly in proportion, the observations are, on the whole, less clear than with the wires. In order, therefore, to work under favourable conditions, we must see that the dimensions of the primary are suited to the diameter of the resonator. The limits between which we can conveniently observe the multiple resonance are less extensive than in the case of the wires, but vary easily from single to double, and even more.

‡ M. Hertz places the first node at a certain distance behind the mirror; this discrepancy at the extremity does not seem to occur in our experiments. As we see by the table, the first quarter of a wave length does not show any appreciable systematic difference from the others.

§ We have already published this theorem in a preliminary communication on the subject to the *Société de Physique et d'Historie Naturelle*, Geneva, on May 1st, 1890 (Archives des Sciences physiques et naturelles, vol. xxiii., p. 557); but since then we have taken up these researches anew, varying in many ways the conditions of the experiments, and it is these last experiments that we have summed up in this paper. M. Lecker, of Vienna, has found by quite a new method that the speed of the electric undulation along a wire is equal to that of light.

shaped fragments, which appear to consist of an alloy of iron, nickel, and cobalt, probably of the formula Fe_8 (Ni Co): these fragments are very strongly magnetic.

Reichenbach's "tænite" was also found: this is another compound of iron, nickel, and cobalt, associated together in proportions represented by the formula Fe_5 $(Ni\ Co)_2$. It occurs in thin, silver-white, strongly magnetic lamellæ.

The most interesting mineral found in these meteoric masses is a new one, for which Weinschenk has proposed the name "cohenite." It is a curious compound of iron, nickel, and cobalt with carbon. It occurs in white regular crystals, resembling tin in colour, and which are very strongly magnetic. Chemical analysis revealed the composition to be $C\ (Fe\ Ni\ Co)_3$.

Weinschenk claims to have discovered diamonds in this meteoric iron. He compares the varieties of carbon met with in these meteorites with those in pig-iron. The "hardening carbon," about which we have heard so much lately from Professor Roberts-Austen and others, corresponds with the carbon given off as hydrocarbon when meteoric iron is dissolved in hydrochloric acid; the ordinary "carbide iron" with "cohenite;" graphitic "tempering carbon" with the carbon in the residue when meteoric iron is dissolved; and, lastly, graphite is met with in both varieties of iron.

This perfect analogy leads to the assumption that the conditions under which meteoric iron was formed are comparable to those under which pig-iron is produced, and the presence of the diamond indicates that the carbon dissolved or chemically combined in iron can, under certain conditions, separate out in the allotropic form of the diamond.

AN ELECTRICAL METHOD OF DETERMINING THERMAL EXPANSION FOR EQUAL QUANTITIES OF HEAT.

THE expansion caused by the communication of one calorie of heat may, according to E. J. Dragoumis, be determined in a new way as follows:—

A dilatometer packed with cotton wool is used. This contains the substance, the thermal expansion of which is to be determined. The instrument also contains a spiral of platinum wire, the ends being fused through the walls.

The substance is heated by means of the platinum spiral through which a current of about 0·2 ampère is passed.

Since the current can be easily and accurately measured it is possible to determine the amount of heat that is communicated through the spiral to the substance under examination, and the thermal expansion due to this can be observed.

The calculation of the results of the observation is performed by the following scheme.

Let v = the volume of the substance.
„ ξ = its weight.
„ a = its coefficient of expansion.
„ c = its specific heat.
„ Δt = the rise of temperature.
„ Λ = the expansion caused by the communication of 1 cal.

Then $$\Lambda = v\, a\, \Delta t.$$

But $$\Delta t = \frac{1}{c\,\xi},$$

and $$\frac{v}{\xi} = \frac{1}{s};$$

therefore, $$\Lambda = \frac{a}{c\,s}.$$

In the case of gases, Λ is evidently inversely proportional to the molecular heat, for a is constant for all gases, and s varies inversely as the molecular weight. Comparative experiments with various substances have been made, and the results found to be very satisfactory.

THE HUNGARIAN MINISTER OF COMMERCE AND THE BUDAPEST ELECTRICAL TRAMLINE.

[FROM OUR OWN CORRESPONDENT.]

I HAVE recently called your attention to an "interpellation" brought forward in the Budapest Council of Municipal Representatives by occasion of the fact that members of the Metropolitan Tramway Commission have taken part in the conclusion of the definitive agreement between the capital and the Electrical Tramway Company of Siemens and Halske, and have immediately afterwards been elected directors of the joint-stock company, which was floated by the Anglo bank simultaneously with the Austrian General Electric Company, and concerning which it was said by the whole Press that it had acquired the Budapest tramline from the firm of Siemens and Halske.

In consequence of this, the persons referred to in the interpellation leave the board of the Metropolitan Railway. At the same time there appeared an explanation by the line in question, which conveyed to the public the startling intelligence that the Budapest electric line was the exclusive property of Siemens and Halske's town line undertaking, and that at present no agreement existed between this undertaking and the electric railway company.

This explanation has been variously interpreted, and further light is thrown upon it by a peculiar edict of the Royal Hungarian Minister of Commerce. This edict runs as follows—

To the Budapest Town Line Undertaking—Siemens and Halske.

The shares issued in Budapest by the Municipal Electrical Line Company enjoy, as it is said, a great demand, and are bought and dealt with at a considerable premium, and, as I have been informed, on the supposition that the abovementioned company has bought up electric lines for which the Siemens and Halske Company have received a concession, or that the company has been constituted for the purpose of working these lines.

According to the stipulations of the concession granted to the undertaking of Siemens and Halske for constructing and working the electric lines, this concession can be assigned to another undertaker only after my consent has been previously obtained.

As I cannot allow a possible deception of the public, I inform the Budapest Town Lines Undertaking—Siemens and Halske—that it must explain to the public through the press in such a manner as to exclude every doubt concerning the kind of relation existing between the said company and the representation of the city, and that it must report to me within three days, and in the unexpected case that the company should, in spite of its obligations, was founded by the Siemens and Halske undertaking as concessionary for the electric tramways, it must apply for my sanction with an immediate exposition of its prospectus and rules, and pending my sanction the activity of the company, and especially the issue of shares, must be suspended.

The *New Pester Journal*, a respected paper of extensive circulation, approves of the attitude taken by the Minister Baross, and hopes that he will succeed in shutting the door against the tricks of the share market.

This letter does not deal with electro-technics at all, but discusses financial stratagems.

ELMORE'S COPPER TUBES.

MR. ALEXANDER WATT sends the following letter to the *Financial Times*, under date of April 4th:—"As to the system of floating company after company to purchase patents for a process which in no degree has been proved to be a commercial—or even a practical—success, I will leave such matters to the consideration of the financial Press, trusting that it will look well after the public interest with increasing watchfulness. There are, however, some practical points respecting the character of the copper deposits obtained by the so-called 'Elmore process' to which I should like to

direct attention, in order that the public may judge for themselves as to whether the merits of this process are equal to the plausible representations that have been put forth concerning it.

"I have before me a copy of the *Engineering and Mining Journal*, of New York, dated 21st March, which contains a leading article on the Elmore process, one or two passages from which I will quote. The writer says, 'Unfortunately, it is only in actual practice that the defects of what in theory seems to be a satisfactory process can be ascertained; and, in the case of Elmore's invention, the difficulties appear to come in the foliated character of the deposit, which, notwithstanding the pressure of the burnishers, upon heating even to a very moderate degree, exfoliates. . . . If we are correctly informed from what we consider reliable sources, the company owning the Elmore process is not content to await the perfecting of the process before reaping a harvest; indeed, it is very openly charged that the process is being worked as a stock speculation rather than an industrial investment.' Now, with respect to the 'exfoliation' of the copper deposited under the influence of a burnisher, as in the Elmore process, I will direct attention to one or two practical facts which may tend to dispel some of the illusions which the public have been led to entertain as to the extraordinary merits of the 'Elmore process.' In the first place, it may be accepted as a fact that electro-deposited metals do not adhere to polished or burnished metallic surfaces. If, therefore, a burnisher passes over the surface of a revolving iron mandril coated with copper, it leaves a bright and highly polished (or burnished) surface to receive the next deposit, with which it has no cohesion, and thus becomes a distinct and separate layer or film; and this deposition of non-adherent, and indeed laminated, metal, layer upon layer, goes on throughout the entire body of the metal deposited, rendering it totally unfit to withstand even a very moderate heating without coming to grief in some way—disintegrating, in fact. Again, the action of the burnishers, under a pressure, as we are informed of from 3 to 13 lbs. would cause the non-adhering films of metal to expand, and thereby assist the separation of the respective layers in contact with, but not adhering to, each other. A soft metal, such as copper, would expand very considerably under a burnishing pressure of even 10lbs., or much less when applied to a very thin film of the metal—such as would be deposited before the Elmore burnisher made its return journey over the revolving copper tube. If, therefore, the exfoliation of the metal be due to the cause I have pointed out, it is not a remediable defect, since the action of the burnisher is solely responsible for the foliated condition of the metal. There is another fact in connection with the electro-deposition of metals, which is very likely to be overlooked, but which must be considered when comparing the professed superiority of the electro-deposited tubes with ordinary drawn tubes. It is this: Metals deposited electrolytically do not adhere well, if at all, to their kind. Thus, gold will not adhere to gold, nickel to nickel, nor copper to copper. If, therefore, there be any breaks in the continuity of the deposition—even for an instant, and quite irrespective of the receiving surface being excluded from the air by the surrounding liquid, or electrolyte—as soon as the operation again proceeds the subsequent deposit will, I believe, be a distinct and separate layer or film, and as often as such breaks occur so will there be deposited a succession of separate layers of the metal—one tube over another, as it were. But even this probable cause of mischief is as naught compared with the more serious evil of foliation, for which there would appear to be no remedy but the abandonment of the burnisher."

NEW PATENTS—1891.

5,131. "Means for applying electricity through jets, streams, or sprays of fluids and vapours for therapeutic and other purposes." H. N. Lawrence. Dated March 23rd.

5,135. "Improvements in armatures for dynamos or electric motors." B. D. Southard. Dated March 23rd. (*Complete.*)

5,162. "Improvements in devices for transmitting power, the same being specially adapted for use with electric motors, propelling cars, or vehicles." B. J. B. Mills. (Communicated by E. H. Johnson, United States.) Dated March 23rd.

5,167. "An improvement in the manufacture of tubes by electrolysis." F. E. Elmore and A. S. Elmore. Dated March 23rd.

5,192. "Improvements in electric clocks." W. S. Scales. Dated March 24th. (*Complete.*)

5,247. "Improvements in electric heating apparatus." M. W. Dewey. Dated March 24th. (*Complete.*)

5,252. "Electric signal apparatus for railway trains." E. D. Graff. Dated March 24th. (*Complete.*)

5,280. "Improvements in electric switches." W. P. Thompson. (Communicated by Willing and Violet, Germany.) Dated March 24th. (*Complete.*)

5,313. "An improvement for driving electrical machinery." H. Aylesbury. Dated March 25th.

5,318. "Improvements in or relating to arc lamps." F. R. Boardman and J. S. Fairfax. Dated March 25th.

5,329. "Improvements in portable electric safety lamps." L. Bristol. Dated March 25th.

5,338. "Improvements in the form of carbons used in certain electric arc lamps." T. P. C. Crampton and A. Essinger. Dated March 25th.

5,341. "Improvements in electrical transformers." A. Poleschko. Dated March 25th.

5,342. "Improvements in electrical thermometers or pyrometers." H. L. Callendar. Dated March 25th.

5,343. "Improvements in electric arc lamps." J. Brockie. Dated March 25th. (*Complete.*)

5,350. "Mounting electrical dynamo machines or motors to enable them to be easily reversed for driving in alternate directions." R. R. Harper. Dated March 25th.

5,370. "Improvements in and connected with dynamos or other electric generators, and motors and accumulators, and other appliances." P. H. Williams. Dated March 26th.

5,371. "Improvements in and connected with telephones and telegraphs, and apparatus and appliances therefor." P. H. Williams. Dated March 26th.

5,382. "An improved electro-magnetic hat leather or lining for hats, caps, and other similar head coverings." J. Harris. Dated March 26th.

5,404. "Improvements in or relating to fittings for electric and other lamps." J. Clift. Dated March 26th.

5,406. "Improvements in attachments for telegraph poles for carrying insulators." H. C. Jobson. Dated March 26th.

5,435. "Improvements in electric magnetic massage kneaders." D. Lichtenstadt and C. Lichtenstadt. Dated March 26th. (*Complete.*) [Date applied for under Patents Act, 1883, Sec. 103, 8th December, 1890, being date of application in United States.]

5,461. "Improvements in masts and trolleys for the overhead system of electric traction." A. Dickinson. Dated March 28th.

5,845. "Improvements in the means for telephonic communication." E. Massin. Dated March 28th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1890.

232. "Improvements in electro-motors and dynamo-electric machines." J. Hopkinson, E. Hopkinson, and G. A. Grindle. Dated January 6th. 8d. Claims:—1. In electric locomotives or in vehicles propelled by electric motors the combination of two or more armatures having independent parallel shafts, each driving an axle or axles, with field magnets arranged so as to form a single magnetic circuit, which includes the armatures, the lines of magnetic force passing through the armatures in succession. 2. The construction of contact pieces or brushes for commutators from a carbon rod held in a split tube or holder of brass or other metal or material through which contact is made. 3. Carbon contact-pieces constructed as described in combination with metal plates to which they are attached, and which are placed tangentially to the commutator and held by a holder and spindle, the contact against the commutator being obtained by spring in the plates or by a spring in the holder, or by connecting the opposite plates by a spring. 4. The combination of the carbon contact piece and split tube or holder with a smaller plate to which the tube is attached, with a pocket or recess on the tangential plate, as and for the purpose described. 5. The combination of the single magnetic circuit and two or more armatures, substantially as and for the purposes described.

873. "Improvements in electric supply meters." J. Perry. Dated January 17th. 8d. This principle is that an electric motor either with permanent field magnets or shunt electro-magnets, resisted in its motion mainly by Foucault currents, gives a good supply meter. 8 claims.

911. "Method of and apparatus for winding ribbons or tapes of insulating material around electrical conductors." Sydney Pitt. (A communication from abroad by J. B. Atherton, of New York.) Dated January 17th. 8d. According to the present invention, the wire passes centrally through the paper bobbin or roll, which, being revolved as the paper is taken from it, the paper is laid spirally around the wire. 7 claims.

993. "Improvements in holders for incandescence electric lamps." J. W. Edmundson and W. Clarke. Dated January 20th. 8d. Comprises two porcelain blocks, with or without a cap or cover. Between these blocks there are secured a number (say four) of springs or prongs, shaped to embrace the lamp neck when it is applied to the holder, and the grasp of these springs or prongs is further aided by an elastic ring, such as a ring of spirally wound wire, which is placed

around the lamp neck outside of the springs or prongs. The two porcelain blocks are bolted together, and are provided with holes for the passage of the lamp wires, and terminals by which they may be secured. 2 claims.

1,072. "Improvements in electrical switches." G. BINSWANGER. Dated January 21st. 6d. In one form a lever moving on a centre is supported on a suitably shaped frame (preferably of metal), the said frame being secured on to a base of suitable insulating material. The lever has at or near its centre of motion, on its upper side, two teeth or suitably-shaped projections, which gear with one or more teeth forming part of another lever, this lever being pivoted in such a manner as to allow of the teeth gearing together loosely. The second lever, being suitably shaped, serves as an actuating device or handle. On the lower part of the first (or contact) lever directly under its centre of motion is a cam, either formed out of the same piece as the lever or suitably attached to it, triangular in form. A strong flat spring, suitably curved at one end and fastened at the other, either to the base or to a convenient part of the frame, presses against the cam in such a way as to tend to keep the cam on one side or other of the centre of oscillation. 1 claim.

1,143. "Improvements in or connected with telegraphic apparatus, applicable for use in navigable vessels and analogous purposes." W. CHADBURN. Dated January 22nd. 8d. Consists in causing the moving part, whether it be the pointer or the dial, to move automatically, and to the full correct and desired distance and point, by a partial movement of the means, device, or medium on which it (the dial or pointer) is mounted or by which it is operated. 6 claims.

1,903. "Improvements in the method of treating nervous and other disorders of the human system, and apparatus therefor." W. P. THOMPSON. (Communicated by the Electrolibration Company, of America.) Dated February 4th. 8d. A metallic cord or wire or other conductor is used, provided at one end with a clasp or means of attachment to the body of the patient, and at the other end with a metallic body of suitable character, such for example as a case or shell filled with iron wires or small fragments of iron. 3 claims.

3,082. "An improvement in filaments for incandescent electric lamps." R. LANGHANS. Dated February 26th. 4d. Claim:—The process of covering carbon and metallic filaments for electric incandescent lamps with an electrically-conductive coating which is but little or not at all attacked by oxygen and oxydising gases, this process consisting in bringing the filaments, within a vessel evacuated of air or filled with chemically indifferent gases, in contact with a compound of silicon or boron capable of being decomposed so that silicon or boron separates out in graphitoidal or crystalline form, and exposing the filaments to the action of heat, or of an electric current, or both, with or without the aid of a chemical decomposing medium.

3,094. "Improvements in portable electric lamps, more especially intended for miners' use." THE MINING AND GENERAL ELECTRIC LAMP COMPANY, LIMITED, D. G. FITZ-GERALD, and A. H. HOUGH. Dated February 26th. 8d. The casing of the lamp is made of metal, preferably steel, with a lead lining and coating to prevent its being injured by the electrolyte. The elements and electrolyte are contained in a cell, preferably of ebonite, and of such size as to leave a space between it and the metal casing, and in this space pieces or discs of India-rubber or other elastic material may be placed, so that the cell is prevented from being injured by any blow which the casing may receive. 5 claims.

6,032. "Improvements in electric heating apparatus." M. W. DEWEY. Dated April 21st. 8d. The heating devices are in the shape of a floor-mat, which may extend over the entire floor or only a part of the same, so that the heat may be equally diffused throughout the room or apartment. 14 claims.

6,037. "Improvements in and relating to electric railway vehicles." M. W. DEWEY. Dated April 21st. 8d. The object of the invention is to enable the conductor of a car or the passengers thereon to communicate easily and instantly with the motorman when it is desired to have the car started or its speed increased or decreased, or to have the car stopped, and, to effect such communication by means of suitable electric signalling devices in a shunt-circuit around the motor for propelling the car, both the motor and signalling devices being supplied with current through electric connections with the working conductors arranged along the track. 8 claims.

8,392. "Improvements in tubes or conduits for electric cables." W. P. THOMPSON. (A communication from abroad by J. Frères et Cie, of Paris.) Dated May 30th. 6d. This conduit is operculated preferably rectangular in shape, having the corners slightly rounded. The upper part fits on the lower part, the joint following a broken line, the shape of which is shown in the drawing, and forms a covering completely joined. This lower part is fitted with insulating supports, which have a longitudinal groove for receiving the cable, and a circular fluting (or neck) for insuring the insulation. At each extremity of these longitudinal grooves, fixing tenions of any suitable shape, form projections on the front and back walls of the insulating supports, and ensure the cables being held firm by means of any suitable material wound round them. 2 claims.

12,830. "Improvements in secondary batteries and electrodes therefor. H. H. LAKE. (Communicated from abroad by G. A. Johnson and S. L. Holdrege, of America.) Dated August 15th. 8d. The main feature of that part of the invention relating to the battery is the arrangement of the active material in a number of masses, each of which is in the form of a strip, substantially rectangular in cross-section, and surrounded on all sides with the enveloping material; each electrode being made up of a number of metallic boxes filled with the active material, and so arranged and secured together as to form a compound box divided by partitions into a number of compartments, each compartment containing a mass of the active material in the form of a long strip with four sides, and the enveloping material being perforated to allow proper circulation of the electrolyte. Another feature of the invention relates to the formation of the outer plates or electrodes when three or more are used in one cell, and consists in making the outer plates considerably thinner than the plate or plates between them. 5 claims.

12,979. "Improvements in thermo-electric generators." H. B. COX. Dated August 19th. 8d. The object of the invention is to produce in a thermo-electric circuit as pronounced a fall in potential as possible, and to produce as large a movement of heat within the circuit as possible. A further object of the invention is to provide an improved construction of thermo-electric generator and furnace. 12 claims.

13,233. "Improvements in portable electric lamps, more especially intended for miners' use." THE MINING AND GENERAL ELECTRIC LAMP COMPANY and W. MOSCROP. Dated August 22nd. 6d. The inventors make the incandescence lamp bulb itself or the protecting glass which covers it or both of them, so that they are held in their protruding position by a spring or springs, which, on a blow or pressure upon either or both of them occurring, will allow either or both of them to yield, and so prevent their fracture, or render them less liable to fracture than would otherwise be the case. 2 claims.

13,421. "Improvements in apparatus for working or welding metals electrically, and in the method of effecting the same." W. P. THOMPSON. (A communication from abroad by C. L. Coffin, of America.) Dated August 26th. 8d. Relates to apparatus for bringing the edges or ends of two articles, which are to be welded, in contact or nearly so, clasping the edges to be welded between conductors, connecting one of the articles to be welded with one pole of a generator of electricity, connecting the clasp which embraces the edges to be welded with the other pole of a generator, and passing a heating current through the circuit thus formed. 5 claims.

13,635. "Improvements in or appertaining to electric welding." W. P. THOMPSON. (A communication from abroad by C. L. Coffin, of America.) Dated August 30th. 6d. In one arrangement a voltaic arc is formed in such manner that it shall extend outside of a straight line joining the ends of a positive and negative conductor, and then drawing the conductors while the current is passing along the joints to be welded, whereby the joint is submitted to the action of the voltaic arc; and, as an addition to this process, the invention further consists in feeding to the joints to be welded and within the influence of the voltaic arc a strip of metal, which is fused by the arc and deposited on or in the joint, whereby the welded joint is re-enforced. 4 claims.

13,636. "Improvements in electric welding." W. P. THOMPSON. (A communication from abroad by C. L. Coffin, of America.) Dated August 30th. 6d. By the invention, the joint is re-enforced by making one of the conductors between which the arc is sprung which traverses the joint, of metal, so that when fused by the arc, the molten metal will fall on and re-enforce the joint. 3 claims.

13,751. "Improvements in electric switches." C. W. HUNTINGTON. Dated 2nd September. 6d. The switch consists of a base of insulating material, in the face of which a circular groove or channel is formed, the bottom of the channel being formed of an even number of inclined planes, the opposite ends of each of which are respectively in two parallel planes. The surfaces of alternate planes are armed with metallic plates, and the others are left bare. The number of the inclined planes should not be less than four, and this is the number it is preferred to employ. A centrally pivoted circuit controlling arm is pivoted with contact brushes at its opposite ends, which, when the arm is turned in one direction, drag over the inclined surfaces and make or break the electric circuit. A spring is suitably arranged in connection with the circuit controlling arms to hold the brushes in contact with the inclined surface. 1 claim.

13,790. "Improvements in conduits for electric conductors and in means for collecting the current from the conductors." H. H. LAKE. (Communicated from abroad by H. N. Curtis, of New York.) Dated September 2nd. 11d. The invention is embodied in a conduit which may be made of any suitable material, and has a narrow longitudinal slit or opening in its upper surface which constitutes a portion of the roadway over which the vehicles travel, and contains a current supplying conductor suitably supported in the conduit below the said slit, and the said invention consists mainly in the combination with such a structure of a flexible conduit slit cover contained within the conduit and normally pressed upward against the inner surface of the top thereof, so as to close the slit from below. 5 claims.

13,802. "Improvements in electrical measuring instruments." G. W. WALKER. Dated September 2nd. 8d. Relate more particularly to the means for moving or vibrating the needle or other indicating portion thereof, and has for its main object to provide a construction whereby the deflections or movements of the indicating device may be proportional, or substantially so, to the strength of the electric current employed, in order that an equally divided or graduated scale may be employed, and in order that uniform deflections and readings may be obtained. 7 claims.

13,905. "Improvements in and relating to the welding of metals by electricity." M. W. DEWEY. Dated September 4th. 8d. Consists in making contact with both pieces to be united, and passing a current of greater strength or volume through one piece than the other. Consists also in making contact with both pieces to be united, passing currents through both pieces and proportioning the volume of the currents to the conductivity of the pieces to produce the same welding temperature in both pieces simultaneously. Consists further in clamping said pieces at an angle to each other, passing a current through said pieces until they are sufficiently softened, and then pressing the pieces together to unite them while maintaining them at the angle at which they were clamped. 8 claims.

13,906. "Improvements in and relating to the welding and brazing of metals by electricity." M. W. Dewey. Dated September 4th. 8d. Consists essentially in electrically heating the material at the junction to soften the same as by passing a heavy electric current from one side to the other of the joint, and then, when the material is properly heated, subjecting the joint to a force tending to compress and twist the same. 7 claims.

14,186. "Improvements in electric switches." C. G. Perkins. Dated September 9th. 8d. The principle of the switch is that of storing power during the initial movement thereof, and afterwards releasing the power to effect the quick movement of the contact parts. 12 claims.

14,191. "Improvements relating to electric railways." M. W. Dewey. Dated September 9th. 8d. Consists in providing suitable apparatus for transforming or converting the current or a portion of the current received on the car into a current of lower voltage and larger volume and by placing the lamps in multiple connection with a secondary circuit through which the transformed current flows, and further in providing switches for each of said lamps in circuit so that one or more of the lamps may be lighted while one or more others are not lighted. 23 claims.

14,603. "Improvements in electric signalling apparatus." W. R. Lake. (Communicated from abroad by the Hall Signal Company, of America.) Dated September 16th. 8d. Consists in prolonging the cores of an electro-magnet beyond their helices and mounting a novel constructed armature on a shaft, whose bearings are contained in a brass bracket which holds the electro-magnet, cause it to revolve between the cores of the magnet when the magnet is energised. The prolonged cores and the armature are both curved upon the arc of a circle, the radius of the cores being about $\frac{1}{64}$th of an inch greater than that of the armature. The signal disc is attached to the shaft on which the armature rotates, and as the intervening space between the cores and armature is just sufficient for the armature in its revolution to clear the cores, together with the fact that whatever position the signal assumes, the distance between the cores and armature remains the same, the signal can be operated with a much less number of cells of battery than in heretofore devised automatic electro signals. 12 claims.

14,604. "Improvements relating to the heating of metals and other materials by electricity." M. W. Dewey. Dated September 16th. 8d. By means of the invention a weaker current may be employed, the same strength of current may be used for work of various sizes, blanks of various and peculiar shapes can be worked with one and the same apparatus, many articles can be heated at the same time, large bars or blanks may be quickly heated although the current used may be weak on account of the great amount of heat that may be stored before the work is subjected, and an expert operator is not required. 9 claims.

14,817. "Improvements in and relating to the distribution of electrical energy." R. Kennedy. Dated September 19th. 8d. In the new system of distributing electrical energy two alternating currents alternating at a difference of phase equal to a quarter of a complete period of alternation are generated at a central station by one or more dynamo-electric machines or generators. These currents are rectified into two unidirection pulsating currents by rectifying commutators on the generators and these two currents are then distributed by main conductors, preferably four, one pair for each pulsating current. Devices requiring pulsating currents are connected to and supplied from either pair of mains; devices requiring continuous unidirection excitement are double wound and connected the one winding to one pair of mains the other winding to the other pair of mains, so that the currents flow in the same direction in both windings and the same devices are operated when singly wound by the two currents in series between the two pair of mains. Devices requiring alternating excitement are likewise double wound and also connected the one winding to one pair of mains and the other winding to the other pair of mains, but the connections are made so that the current in the one winding flows in the opposite direction to the current in the other winding. By coupling one main of the one pair to one main of the other pair through a conductor at the central station (which preferably forms a coil round the dynamo magnet) the inventor puts the two pulsating currents in series, and can obtain them in series from the other two sides of the mains and such pulsating currents are suitable for charging storage batteries and operating motors or lamps. 7 claims.

15,482. "Improvements in and relating to electric batteries." H. H. Lake. (Communicated from abroad by Crosby Electric Company, of America.) Dated September 30th. 6d. Claims:—1. A containing jar for electric batteries constructed of paper stock or similar material prepared with an outer coating of shellac and an inner acid proof coating composed of paraffine and ozocerite, substantially as described. 2. In an electric battery an acid proof containing jar, an absorbent pad disposed therein, a zinc plate and carbon plate resting on said pad and surrounded by a packing containing a dry excitant, substantially as described. 3. In an electric battery the combination of an acid proof containing jar, a zinc plate, an absorbent pad saturated with an excitant, and a carbon plate in contact with said pad and surrounded by a packing containing a dry excitant, substantially as described. 4. In an electric battery, a packing separating the positive and negative plates and comprising sawdust or wood fibre mixed with an excitant in a dry or crystallised form, substantially as described. 5. In an electric battery the combination of a paper containing jar coated with an acid proof composition, a zinc plate, a pad of absorbent material disposed within said jar and containing a liquid excitant, a carbon plate on said pad, and a packing comprising sawdust and a dry or crystallised excitant surrounding said carbon, substantially as described.

CORRESPONDENCE.

Electrically Charged Spheres.

Mr. Cheshire's letter on the above subject in your last issue, with its imposing array of mathematical symbolism, struck me as being a case of "Much cry for little wool." The result he obtains after much labour may be directly obtained from Maxwell's definition of specific inductive capacity.

We find in Maxwell's "Electricity and Magnetism," Vol. I., p. 94, the following:—

"We may express the theory of Faraday in mathematical language, by saying that in a dielectric medium the induction across any surface is the product of the normal electric force into the coefficient of specific inductive capacity of that medium."

Now, as the induction here means the quantity of electricity induced by a given electromotive force on the surface of a conductor, this definition may be stated in Mr. Cheshire's symbols

$$F \sigma \propto Q$$

which is identical with Mr. Cheshire's result.

J. Murray.

Cambridge, *April 4th*, 1891.

Duplex and Quadruplex Telegraphy.

As an operator I am much interested in your journal, and number after number do I scrutinise carefully with the hope of finding something on practical telegraphy, or some such subject as would interest a wire tapper, but have always been doomed to disappointment; then I begin to think that telegraphy proper has perhaps exhausted itself, and there has been no further improvement or advance made since duplex and quadruplex saw the light. The paper on electro-magnets, by Silvanus Thompson, has afforded many of your readers interest, being altogether a very practical one.

With a view to obtain a little knowledge and to improve the minds of others equally grasping, would you deign to give space in your columns for the following, and be pleased to make explicit replies:—

(*a*). The G.P.O. standard relay is said to be more sensitive than the Siemens polarised improved pattern. Why?

(*b*). If the latter had larger pole pieces or shoes, would it improve its sensitiveness or working efficiency? in what manner would the inductive capacity be affected, whether to its advantage or otherwise?

(*c*). In the bridge system of duplex, the bridge wire is shunted with condensers; why, and what capacity is necessary per 100 miles?

(*d*). In the differential system of duplex would there be any advantage if each of the coils of the differential relay were shunted with equal condenser capacity?

(*e*). It is considered an advantage in quadruplex to have the neutral or non-polarised relay of short cores, but as the duration of "no current" at the time of reversal is a function of the length of the line, increasing with its length, will not large cores act better, being less quick working?

(*f*). To bridge over the time of "no current" in quadruplex, both in the differential and bridge systems, condensers are used to shunt the relays. What average capacity per 100 miles is necessary?

(*g*). In (*f*) which is the best form of condensers to employ, would one on the principle of Planté's secondary battery of lead plates with sufficient resistance answer well?

(*h*). As in *d*, if the "line" circuit and "compensation" circuit of the relays in quadruplex were each shunted with condensers of equal capacity, what effect would it have on the working of the system?

Indian Student.

Madras, *March 11th*.

[(*a*). The moving parts in the G.P.O. standard relay are lighter than those in the Siemens, and they are better balanced, *i.e.*, there is less drag on the pivots; there are also two tongues acted upon instead of one, as in the Siemens, and, owing to the absence of the cross piece on the magnet,

the cores demagnetise more readily, and there is therefore less liability to sticking. The improved Siemens pattern is, however, very good for key speed working.

(*b*). An increase in the size of the pole pieces would not improve the working, it would make practically no difference unless they were very massive, in which case the sensitiveness of the relay would be reduced owing to there being a large amount of iron to magnetise. We do not know what you mean by "inductive capacity;" an electro-magnet has no inductive capacity; it has "self induction," and this would be increased by increasing the size of the pole pieces.

(*c*). It is not clear what you mean by "bridge wire;" the capacity for balancing the discharge from the line for a 100-mile line would be between 1 and 1·5 microfarads if the line were all open work (no underground).

(*d*). No advantage whatever.

(*e*). Lengthening the cores would aggravate the effect of the slow discharge from the line and would certainly not improve the working.

(*f*) (*g*). Experience has proved that the use of condensers is absolutely unnecessary, and no beneficial effect results from their use. A secondary battery would be perfectly useless, as the discharge would be too prolonged and uncertain.

(*h*). Practically no beneficial effect whatever.—EDS. ELEC. REV.]

The Elmore System of Patent-Making.

The system of "gleaning" patent specifications for the purpose of strengthening otherwise useless "inventions," is by no means of rare occurrence, but in most instances in which the field of invention is explored, it is the blue-books of defunct patents that furnish the happy hunting ground to the *soi-disant* patentee, or "first and true inventor," if he prefer it. I am led to these reflections in consequence of having discovered that Mr. A. S. Elmore, in a patent to which his name is attached, has had the temerity—I should say audacity—to pluck from a patented process of mine, which is still in force, an important part of my invention. Now, before pointing out to the readers of the ELECTRICAL REVIEW the particular part of my process which Mr. A. S. Elmore has thought fit to appropriate for the purpose of giving to his otherwise perfectly useless patent, a semblance of practicability, it will be necessary to refer to other portions of his somewhat obscure specification, which has for its title "Improvements in *the* process (*sic*) of obtaining zinc by electrolysis." Improvements in *the* process! Which process?

In this patent the zinc, while being deposited upon the cathodes, which are in the form of a disc or cylinder, is subjected to the action of a burnisher, "but," says the patentee, instead of being *in the loose granular state, such as it would have under the ordinary conditions of electrolytic deposit*, it is rendered compact, &c., and "when the deposit has attained the desired thickness, the zinc can be removed in the form of round plates from the discs, or it can be cut longitudinally and stripped off the cylindrical cores." Now with respect to the "loose granular state" of electrolytic zinc "under ordinary conditions," referred to in the above passage, which I have italicised, I have something to say. It is well-known, or should be known, that the Elmores have made many attempts—notably in various parts of Wales—to deposit zinc from its sulphate solutions, and ingloriously failed in every such attempt, and when A. S. Elmore, having the remembrance of those disastrous failures vividly before him, speaks of "the loose granular state" of zinc "under the ordinary conditions of electrolytic deposit," he is simply echoing his own experience of his father's failures in respect of the electro-deposition of zinc from its sulphate solution. I had heard of those failures, as also those of others who had attempted to deposit zinc in a practical scale from a solution of the sulphate, and I had also had a good deal of personal experience myself with respect to this salt of zinc. Knowing the importance that would attach to a good zinc bath, if such could be found, I pursued a long series of experiments with solutions of various zinc salts, employed under many varying conditions, and eventually succeeded in obtaining an electrolyte which entirely overcame all the old troubles, polarisation, granular deposits, "treeing," and other objectionable features, for which the sulphate of zinc, as an electrolyte, is more notorious than famous. I resolved to turn my attention to the salts of zinc prepared with the vegetable acids, and some of the results I obtained were remarkable for the fine reguline character of the metal deposited, and its extreme whiteness, the familiar bluish tint of the metal being in some cases scarcely perceptible. Subsequently, further experiment proved to me that a mixture of mineral and vegetable acid zinc salts formed the very best combination for a reliable and practical zinc bath—a mixture of zinc sulphate and acetate being specially useful. For these improvements I obtained the necessary patents, and I am amazed to find that Mr. A. S. Elmore had the effrontry to insert the following paragraph at the end of the specification before referred to: "Although I have mentioned zinc sulphate as the salt treated, other compounds of zinc, such for instance as the acetate, may be similarly treated."

Now the Elmores ought to know perfectly well the nature of my improvements in the electrolytic treatment of zinc, and that the introduction of the paragraph I have quoted interferes with my invention; this being so it is liable to mislead the public, and possibly to involve some manufacturer, unwittingly, in an action for infringement. The opnions of the Press regarding the financial schemes connected with the Elmore companies, are gradually opening the eyes of the public—at last—and I hope shortly to ask the shareholders, through the medium of these columns, if permitted to do so, if they know what is meant by the "Elmore patents," about which they have heard so much, and for which they have paid so dearly.

Alexander Watt.

April 1st, 1891.

Behind the Age.

While perusing your issue of the 3rd inst., my attention was drawn to a paragraph headed "Behind the Age," which stated that someone had written to the *Newcastle Weekly Chronicle* to correct a mis-statement of theirs in speaking of the electric pinnace recently floated, viz., "that the first vessel propelled by electricity was launched a week ago on the Thames," &c., and his letter was not published, which you term was the way of newspaper scientists. It became a matter of interest to me to know whether any notice would be taken of the letter, for I have always regarded the *Weekly Chronicle* as a paper that is in general very far in advance of its contemporaries, and a journal that would stand corrected if the circumstances warranted it. I, therefore, took up the paper on Saturday last, and almost the first letter I read in the columns of "Open Council" was a letter from "Electro-Lux" (presumably your correspondent), calling the editor's attention to the mis-statement referred to. As your impatient and irascible correspondent has given rise to a false impression, the least I can ask of you is that you will do me (a reader of both papers) the equal justice of correcting it.

W. Young.

April 6th, 1891.

[We are pleased to insert this letter, which shows clearly enough that our correspondent of last week was a little premature, that is assuming "Electro-Lux" and himself are one and the same.—EDS. ELEC. REV.]

Electrolytic Action on Ships' Bottoms.

Will you favour me, through the medium of your valuable journal, with your esteemed opinion upon the following: If a steel or iron ship be electro-plated with copper, and, during a voyage the copper plating be knocked off so as to expose a part of the iron or steel plate to the action of the salt water, would there be a galvanic action set up between the copper, iron (or steel) and the salt water, and, if so, would the ship's plate be damaged thereby?

By answering the above you will be conferring a very great favour upon me.

G. E. Bulmer.

April 7th, 1891.

[Decidedly yes.—EDS. ELEC. REV.]